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THE DANGER LURKING BEHIND STRIKES.

ARE WE DRIFTING TOWARD STRONG GOVERNMENT?

By William Nelson Black.

PROBABLY no other people were ever so much attached to their government as the people of the United States have been during the hundred years of their independent career. The picture or statue of the first president is about as familiar to every man as his own face; and so completely has every native-born American trusted to the perfection of our institutions that when the great struggle over slavery came, and a new government was set up south of the Potomac, no attempt was made at any organic changes worth mentioning. The new government simply represented secession without revolution. Or, if differing in any essential particular from the old government, the difference would have been due to an attempt to get nearer to the spirit of the original model. When we reflect that every other civilized government exists in an alternating state of either chronic or paroxysmal revolution, the unchanging career of this country should be thought remarkable.

It has been said in the past that were an election held at any time to reconsider the form of our political constitution, the people would decide unanimously in favor of precisely the form which we now possess. But would the saying be true to-day? Symptoms are not wanting which serve to show that men are becoming dissatisfied with the organism of our political body; and these signs point not forward in the direction of greater freedom and more complete personal independence, but backward toward the socialism of ancient and feudal times.

Two forces are at work to shake the foundations of society all over

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Christendom. The first is made up of the mechanical workmen and laborers, men who, misconceiving the influences that have brought them out of barbarism and surrounded them with the advantages of civilization, are disposed to appeal to government to help them repress the man whom they think their enemy—the capitalist. The second is the capitalist himself, who feels his interests endangered by the assaults of the workmen, and is disposed to put the old gauntlets of tyranny and force on the hands of government for his own protection.

Many reflecting men will recall the recent declaration bearing upon social disorders and government made by Herbert Spencer in a tribute paid to the memory of Tyndall. The following is an extract:

> My faith in free institutions, originally strong (though always joined with the belief that the maintenance and success of them is a question of popular character), has in these later years been greatly decreased by the conviction that the fit character is not possessed by any people, nor is likely to be possessed for ages to come. A nation of which the legislators vote as they are bid, and of which the workers surrender their rights of selling their labor as they please, has neither the ideas nor the sentiments needed for the maintenance of liberty. Lacking them, we are on the way back to the rule of the strong hand in the shape of the bureaucratic despotism of a socialistic organization, and then of the military despotism which must follow it; if, indeed, some social crash does not bring this last upon us more quickly.

Believers in American institutions will read such language with pain; for Herbert Spencer, though educated in a foreign environment, and taught the principles of excessive government from his infancy, was a large enough man to appreciate and believe in the peculiar features of American society; and the declaration sounds like a recantation of faith, if not an acceptance of the tenets of what is called strong government. Unquestionably, Herbert Spencer voices the opinions of many men in England. The tendency to revive the spirit of feudal institutions under the name of county councils, or what not, has been generally observed; and there are doubtless many persons in England who think that the movement will greatly improve the future prospects of the Prince of Wales. It will without doubt. But how many men have we in the United States who are learning to feel in their hearts that the reluctantly changed opinions of Herbert Spencer must be also their opinions?

The social disorders incidental to strikes in this country are, of course, the cause of the changed opinions of Herbert Spencer. He has observed such events as those which culminated in the almost open battles of East Tennessee, the murderous affray at Homestead, the anarchy at Cripple Creek, and the general lawlessness of the recent coal strike, involving nearly 200,000 miners; and we can readily understand why it should be thought in Europe that the remedy against

events of the kind is to be found only in the use of those repressive agencies which are believed, in European countries, to be most effective. Strong government is there thought to mean the control of both the purse and the sword; and as the purse in recent years has been slipping further and further away from political control, the aim is to get it back through machinery that will make the laboring man a dependent upon government. Hence the state railways on the continent of Europe, and the county council movement, with state management of the railways also in contemplation, in England.

In the United States, however, the situation is entirely different. We have never held that the control of either the purse or the sword makes what we call *strong* government, though it may be admitted to make *repressive* government. We have held, on the contrary, from the beginning, that it was an element of weakness; so much so that a large standing army is expressly inhibited, and every power delegated to congress by the federal constitution shows that it was intended to put the corrupting influences of the purse as far away as possible. But have we not a strong government in the United States?

Where in history can we find such a magnificent example of the strength of a political constitution as was offered by our civil war? Both sides in that momentous struggle claimed that they were contending for the constitution; and after a four years' war, involving the services of three millions of men and the sacrifice of many thousand millions of dollars in money, the conflict ended with not a dot or letter affecting the organic features of the constitution changed. The very combatants in that war, when captured by the enemy, set themselves directly to debating constitutional questions with their captors, each striving to appear most loyal to the government, and, finally, after nearly thirty years of peace and unexampled prosperity, following upon the war, we find ourselves still living together under the original contract. Then what is the nature of this constitution which shows such remarkable vitality? Unless it represents a league of independent nations and not a government it must rest upon some general principles which have only to be universally observed to make us entirely secure of the future.

The constitution of the United States designates clearly the powers delegated to congress; and then, to make certain that there shall be no doubt as to the purpose of its authors, the body of the instrument is supplemented by the amendment that follows:

> ARTICLE X. The powers not delegated to the United States by the constitution, nor prohibited by it to the states, are reserved to the states respectively, or to the people.

The purpose of this amendment is clear. It was not to protect local self-government only, but *to define and limit political authority;* and

it was this definition and limitation, which, incomparably more than the Declaration of Independence, gave to this country its freedom. The Declaration of Independence might have led to only the transfer of allegiance from one despot to another; but in the limitation of political powers the despot—whether as an individual or a congress—was made impossible.

Well, we have prospered under the system that we inherited as no other people have ever prospered. Violations of the constitution there have been. The municipality, using the word as a designation of the political organization of cities, was an evolution of feudalism transplanted to this continent, and with its industrial functions it has been a thorn in our side from the beginning. It was planned originally to enable the crown to tax and govern an element of the population in England that was growing into a condition of spontaneous freedom, and it always represented an incongruity in the American system. The states, too, have sometimes forgotten their obligation to observe the principles of the federal constitution. The Erie canal, that much-vaunted but dirty ditch, smelling more offensively than the skull which Hamlet studied, with all sorts of political corruption, was built by the state of New York, and it has deprived the people of the state of at least three of the half-dozen railways which they might long since have had between the city of New York and Buffalo had no political monopoly been erected in the way. But these are exceptional examples. The rule has restricted government to the duties of government; and the results in a hundred years are almost startling. Poor men from all quarters flock here by the hundreds of thousands annually simply because they are better able to find employment in a country which exalts the individual and represses the state than in countries that exalt the state and repress the individual. Yet, our constitution is still threatened. Why, we have college professors teaching the descendants of Thomas Jefferson in books that transporting passengers on the railways is a governing function—or "a function of government"—which possibly does not mean quite the same thing to some present-day minds.

The first cause for the prevailing manifestations of dissatisfaction with our political system is of course ignorance. When Coxey marched to Washington to demand that congress set his battalions at work on country roads, he simply did not know that he was asking for something not among the duties to which congress is restricted by the federal constitution. This was ignorance. But when the New York Chamber of Commerce resolves to cripple an industrial enterprise in New York by forcing the city into the transportation of passengers in competition with a company of citizens chartered by the state, and

holding vested rights derived from the state, we are bound, by courtesy at least, to say that it is not ignorance.

It is undoubtedly true that the social disorders originating in strikes, of which the last ten years have been unusually prolific, are convincing many persons, even in this country, that the boundaries of political authority need enlarging. The man of fortune does not fear government; but he does fear the mob, and he might be willing to sacrifice some of his liberties and opportunities to be more secure. Hence the curious phenomenon of a portion of the two extremes of society, antagonistic as they are sometimes thought to be in everything else, working together for a common end. The workman, captivated by that will-o'-the-wisp known as universal suffrage, thinks that he can control the government against the capitalist, while the man of fortune believes that he will be in less danger of seeing his windows broken if he is surrounded by an army of tipstaves and other government officials.

It is to be hoped, however, that the danger springing from the operation of these two forces is not so great as it seems at the moment. The workmen of this country are not in any considerable numbers adherents of the crank notions advocated in the name of socialism. They are hard-headed, practical men who feel that, under the control of either an employer or a slave-driver, they must earn their living by the labor of their hands, and they are willing to accept the employer. But here is their difficulty. They are not largely men trained in either the science of government or the laws of political economy; and when dissatisfied with the best terms that can be offered under market conditions, they are inclined to appeal to the government, which they think they control, to help them knock out the capitalist. But in this case their control ends when they have reached the demagogue, and they will find this out in the end. Statesmen know that they cannot help them without enslaving them; and they are not willing to invite a civil war which, sooner or later, would certainly follow any attempt at putting them in gyves.

But what shall be said of this other force so ready to meet the workman half-way? The members of the New York Chamber of Commerce have determined that the city of New York shall engage in the transportation of passengers in competition with citizens like themselves trying to conduct a reasonably profitable operation. This body of tradesmen must have seen a new light. "Yes," possibly will respond some of the members, "we have seen a new light. The police of a city that owns a railway will be better able to suppress a mob than the police of a city that owns no railway." Very well; but to still further strengthen the police would it not be best for the city to own or subsidize a general merchandise store for the benefit of the

poor? Perhaps these merchants, however, will not confess to political motives. They only want improved transit. But there is not a man among them all who does not know that the company which they would cripple has been trying for ten years to improve its service, and that it has been foiled through political agencies. Will these merchants improve their prospects by hastening the day when chambers of commerce will be converted into bureaus of commerce and find their then executive offices in city halls?

It is easy to have patience with workmen in this conspiracy against our economic interests. They have a real grievance. They seek a standard for wages that will not leave them at the mercy of employers who are so anxious to cut out their competitors that they would reduce wages, if permitted, to enable them to undersell all rivals in the market. The workmen are right, too, in their contention; for no permanent good comes to the community from a fluctuating standard of wages, however much it may sometimes help the incompetent. They are only sometimes wrong in demanding too much, and in their methods of enforcing their claims. But they themselves are the worst sufferers from these mistakes, and when their resistance does not lead to lawlessness it is not to be too severely censured. But it is hard to have patience with the merchants. They are simply revolutionists without any justification but timidity when they advocate revolutionary schemes.

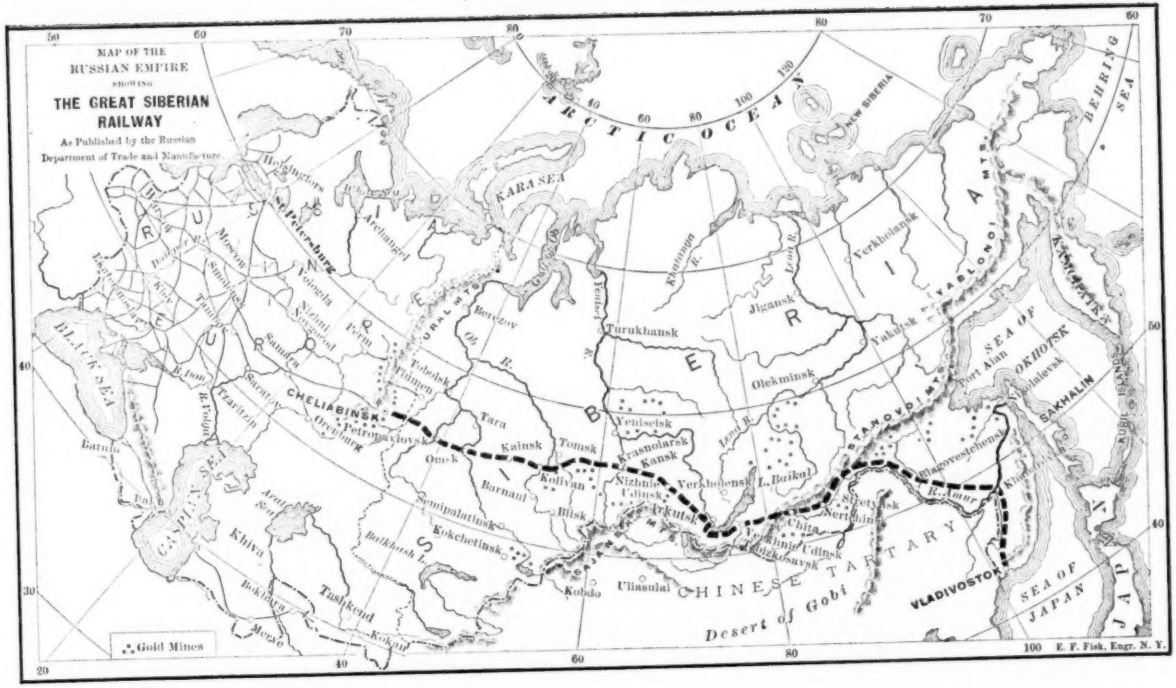
Instead of a weak government, the American system gives us the strongest government on earth. Its functions are specialized and limited to the duties of government. Constitutionally, it never complicates itself with private interests, except in the performance of its police duties; and it holds itself aloof from those conflicts which private interests will continue to precipitate so long as men remain selfish and weak in judgment. This is the secret of its strength; and the little finger of our federal government, which more than the states has been observant of its true relations to the community, is stronger for the suppression of industrial disorders than the right arm of any government in Europe.

But we have terrible riots, it will be objected. True; but there are several reasons, and among them will not be found weak government. First, our people, stimulated by their greater freedom, are more energetic even in mischief-making than the people of other countries. Secondly, we have a large foreign population, habituated to see a soldier always near at hand, and when they see around them nothing of the insignia of authority they think that they can be lawless with impunity. But the third and final reason is better than the other two combined. Our people are very impatient of disorder, and when they

see a mob engaged in lawlessness they labor to suppress it with the utmost diligence and energy.

No, whatever else may be needed to solve the problem of industrial discontent, we certainly do not need a stronger government; and if we did need it, we should not find it in the direction of politically-controlled industrialism—which, properly designated, is state socialism. And we are not without experience. Always a scandal, always the outcropping of some rascality, political or plundering, follows upon the undertaking of productive works by political agents. Witness "Credit Mobilier" and the Star-Route frauds in Washington; "Bill" Tweed and Tammany Hall in New York; the Philadelphia ring and the Keystone bank frauds—in short, political scandals everywhere in connection with works which government should never be permitted to undertake. Yet the public officials of this country are no worse than the officials of other countries. We think them better, indeed; but we have not the danger of revolution before our eyes, and hence do not suppress scandals for the safety of the government.

Our public officials are already too much complicated with industry and finance, and just to the degree of their complication, they lose influence in the performance of their true duties—the preservation of order and the protection of life and property.


MAP OF THE
RUSSIAN EMPIRE
SHOWING
THE GREAT SIBERIAN
RAILWAY
As Published by the Russian
Department of Trade and Manufacture.
ARCTIC OCEAN
KARA SEA
NEW SIBERIA
BEHRING SEA
EUROPE
ASIA
RUSSIA
St. Petersburg
Archangel
Moscow
Nizhni Novgorod
Perm
Tobolsk
Tiumen
Berezov
Obi R.
Yenisei R.
Turukhansk
Jigansk
Verkholensk
Yablonoi Mts.
Kamchatka
Okhotsk
Sea of Okhotsk
Yakutsk
Port Aian
Ayan
Sakhalin
Kurile Islands
CHELIABINSK
Orenburg
Petropavlovsk
Omsk
Tara
Tomsk
Kainsk
Yeniseisk
Krasnoiarsk
Kansk
Nizhnia Udinsk
Irkutsk
Verkholensk
L. Baikal
Stanovoi Mts.
Olagovestchensk
R. Amur
Khabarovsk
Sea of Japan
Vladivostok
Chita
Sretinsk
Nertchinsk
Udinsk
Petrovsk
Barnaul
Kolivan
Biisk
Semipalatinsk
Kokchetinsk
Baikhash L.
Aral Sea
Khiva
Bokhara
Tashkend
Kokand
Kobdo
Ulliasutai
CHINESE TARTARY
Desert of Gobi
BLACK SEA
CASPIAN SEA
Batum
Gold Mines
E. F. Fisk, Engr. N. Y.

THE POLITICAL AND ECONOMIC IMPORTANCE OF THE GREAT SIBERIAN RAILWAY.

By Hermann Schönfeld, Ph. D.

AMONG the greatest achievements of this century in the way of construction of rail- and water-ways must be counted—if accomplished—the Siberian railway. The Suez canal, to a great extent, revolutionized the main lines of international traffic, and it has restored to the Mediterranean countries a share in the commerce of the world such as they had not possessed since the beginning of the modern period. The political importance of the canal is well known to every student of the present political situation of Europe. The Pacific-railway system of America actually created the western states, opening the unbounded wealth and the products of that section to the world at large. But while this railway system of the United States was destined only to serve civilizing and commercial purposes, the Canadian Pacific railway was intended, besides, to carry the military strength of England through the continent to the east against all possible emergencies that might arise, beyond the Pacific ocean, between the conflicting interests of England and Russia. When, in 1885, the Russians had routed the troops of the ameer of Afghanistan and were proceeding against Herat, the nerve shock was felt by England, not only in the endangered Indian empire, but thousands of miles farther on the slopes of the Canadian Pacific, and the fleet stationed there was directed by the foreign office in London to hold itself ready, not to proceed to the Indian waters, but to take Vladivostok, the chief naval station of Russia on the Pacific.

The great Siberian railway is intended to connect the important seaport of Vladivostok—by way of Moscow, which is some 9500 miles distant—not only with the Russian seaports on the Baltic (Riga, Reval, Libau) and the Black sea, but, like a long vital nerve, with all the ports of the European continent. More than that, it will draw the old world nearer to the new and carry the unlimited resources of the Russian empire to our own Pacific states, for direct steam-lines will necessarily follow in time, to complete the circle around the world.

The gigantic Russian empire, with an area exceeding 8,500,000 square miles, or one-sixth of the land surface of the globe, and about 110,000,000 inhabitants, is a world in itself. Its enormous resources, especially in Siberia, will enable it to compete with the greatest commercial nations of the world, when the Siberian railway is once working.

But the principal incentive for the construction of the railway by the Russian government is a strategic one, just as much as in the case

of the Transcaspian railway from the Caspian sea to Samarkand, which, however, has risen to the greatest commercial importance, spreading the sphere of Russian influence to Persia, the Turkoman steppes, Afghanistan, and on the Pamir plateau.* Along its whole breadth Siberia meets the enormous Chinese empire, with its 400,000,000 inhabitants, on the borders of eastern Turkestan, Mongolia, and Manchuria. The profound respect and friendly attitude of the Russian government toward the United States, the policy of which has consciously and sometimes unconsciously for a long time realized the dangers from the same source, as well as the tacit agreement with France, which only nowadays has so energetically pushed forward its boundaries in Siam,—at such a vast sacrifice of blood and money in Tonquin and Cochinchina,—shows clearly that Russia understands very well the necessity of a triple alliance of its own against the Mongolian world behind which England stands. History may repeat itself, and what a Mongolian yoke means Russia has not forgotten. It has not yet been able to free itself from all the traces of that Tartar yoke that weighed so heavily upon the Russian people from 1238-1462, and annihilated their material and political development even for centuries after their liberation.

It is very characteristic what Colonel N. A. Voloshinov, with a slight touch of irony, says before the Imperial Russian Geographical Society: "The Chinese newspapers are full of English articles that clearly prove how weak we are in our east and how advantageous it would be for China to possess our Ussuri provinces. There is no doubt that for the present China will not listen to the evil advice of those foreigners, but there is no doubt either that such conditions can not exist for any length of time. A misunderstanding, however slight, would suffice to destroy our for centuries [*sic!*] cordial relations with China. . . . The Siberian railway shall exist not to embroil us with China; on the contrary, we need it in order to strengthen our friendly relations to China for many centuries to come. When China will know our strength in the east, it will resist the temptations of those who wish ill for Russia and China alike. Besides, Vladivostok is a spicy, tempting bit for any naval power which could wound Russia on that point without any risk of being immediately punished for the outrage. As Sebastapol was in 1856 the aim of the hostile operations of our enemies, so *Vladivostok also will certainly be a similar object for our European enemies.* This must be decisive to build the great Siberian railway in order that Vladivostok may be connected with the central forces of Russia in not more than six years."

* *From London to Bokhara and a Ride Through Persia.* By Colonel A. Le Messurier. Dedicated to Lieutenant-General Annenkoff, under whose direction the Transcaspian railway was constructed. London: 1889.

Perfect harmony exists between Russia and Japan, but the roots of that harmony lie in the common antagonism against China and in the Russian desire of controlling the insular empire in an economic way ahead of the English. Still more in China Russia has to compete with the old-established and obstinately-striven-for prestige of England. On the European boundary of Russia, on the other hand, the antagonism between that power and Germany and Austria is deeply rooted. The prospective discontinuation of the tariff-war between Russia and Germany, arising from *dira necessitas* and yet causing such bitter dissatisfaction in certain agrarian circles of Germany, is only a *provisorium* which, even if passed by the reichstag,—as is to be hoped and wished for,—will change very little the present political state of affairs of those two countries, and may be broken at any time under certain unforeseen tensions and stringencies. The very possibility of the latter must make it desirable for Russia to free herself from any absolute dependence from that side where political considerations may build an unsurmountable tariff-wall.

Thus political causes produce economic effects. Siberia, with its enormous mineral treasures and immense undeveloped products, must be opened for Russia and that country—twenty-five times the size of Germany, two-and-one-half times that of European Russia—is to become by colonization a real power, an empire in itself to feed European Russia, if necessary, to carry by rail the abundance of one part of the realm to the other, and to become a tremendous military power in the east against China and in the south against British India.

The principal impediment to traffic is the fact that even the European regions of Russia are so thinly populated, the average population being but forty-two to the square mile. Siberia,—with its immense area of 4,824,540 square miles, covering more than 25 degrees of latitude and 120 degrees of longitude, with a great variety of orographical and climatological features, with its arid deserts and frozen seas, to be sure, but also with millions and millions of acres of the most fertile soil, and immense mineral wealth,—has only 4,095,535 inhabitants, and is ready to receive many more millions of them. Strange to say, although according to statistics the proportion is 7 dessjatines* of ground to one inhabitant in European Russia against 1½ dessjatine in western Europe, still the Russian peasant has no sufficient soil to support his family with its production. This is due to various causes: division among the many heirs of one family; defective means of tilling the soil; in many portions of the empire to the queer, irrational "commune" system according to which the ground belongs to all and to none; that system of devastating the forests and abusing the soil

*1 dessjatine—2.6997 acres.

which the Germans so adequately call *raubwirtschaft;* the concentration of the ground in a few hands so that for instance in the province (*gouvernement*) of Perm 99.8 per cent of the soil is concentrated in the hands of sixty persons. Therefore the Russian peasants, proceeding from the middle Ural, are moving slowly through south Siberia, occupying the best agricultural tracts in western and eastern Siberia. But since the ways of communication are very poor, traveling being possible only in summer, and under the most unfavorable condisions, requiring at least two summers, the colonization goes on very slowly; yet 44,600 emigrants settled in the south of the province of Tomsk in 1882, and 95,501 persons in the Altai region in 1884-89. But those emigrants who wish to settle in the Amur region have to cross the whole of Siberia, a distance about four times that between Petersburg and Sebastopol. It is natural that 90 per cent. should not reach their destination, but settle anywhere on the way; the few, however, who really penetrate to the Amur have needed often twelve to fourteen years for the passage! This state of affairs makes the colonization of the east practically impossible. Consequently the balance of power between Russia and China stands at present so that Manchuria is populated with 10,000,000 Chinese, and the whole Russian coastland with less than 100,000 inhabitants. And Russia fully realizes the danger of the situation.

The Siberian railway, however, will open an immense territory for emigration and we shall see there the same spectacle which the builders of our Pacific-railway system have presented to the eyes of the astonished world. If we state the distance from Cheliabinsk to Vladivostok at 7100 versts* and the territory to be colonized at 100 versts on both sides of the line, 1,420,000 square versts will be open to European Russia for colonization,—a territory of the size of Germany, Austria, Belgium, Holland, and Denmark taken together. And a beautiful, fertile country withal—the fertile black-earth prairie steppes of the Tobol and Ishim, plains covering some 25,000,000 acres, *i. e.*, a country of the size of France,—having at present only 2,000,000 inhabitants. The net of navigable streams will spread the population in all directions from the railway line along which necessarily many towns and villages will arise.

With the increased and properly-spread population, the immense mineral wealth of Siberia will be made accessible to European Russia, when the present exceedingly poor economic conditions shall be improved by the construction of the great Siberian railway. A highly-developed mining industry will grow at a rapid speed with the possibility of carrying the mineral treasures which lie untouched in the ground of

*1 verst = 0.66269 English miles; 1 square verst = 0.43916 square English miles.

Siberia to Russia proper and to the market centers of the world, of importing improved machinery, and, before all, skilled laborers. For, at present, the condition of the workmen in the Siberian mines is very bad, owing to insufficient food, poor lodging, and the employment of exported criminals. But even under such conditions 1,855 poods* of gold are gained in Siberia every year, and 500 poods in the Ural, or a total of 2402 in all Russia, representing 30,000,000 rubles. Only the United States, with their superior methods and free laborers, surpass the Russian exploitation by 150 per cent., and Australia by 20 per cent., although the Russian territory containing gold surpasses both America and Australia. By reason of the technical insufficiency silver-mining has been almost abandoned in Nirtshinsk and the Altai. As for the extraordinary wealth of iron and coal in the southern Ural, the governments of Tomsk, Tenessei, Irkutsk, and the Khirgise steppes,—the latter also being the "salt empire,"—I may refer the reader to "The Industries of Russia, by the Ministry of Finance," translated by Mr. John Martin Crawford.† Even precious stones are frequent in the Amur domain, and the lapis lazuli in the Baikal mountains. Yet the exploitation stands in no proportion to the actual mineral wealth for the reasons stated above.

But all these disadvantages will be cancelled, labor and freight will become cheap and plentiful, capital will be invested in Siberian mines, and many millions, incalculable at present, which are hidden in the Siberian ground, will flow into the Russian treasury and among the people. The net of Siberian streams will become connected with the Volga, and the tools, implements, and machines necessary for Siberian agriculture and mining will be easily imported. Heretofore these articles bought on the markets of Nishni-Novgorod and Irbid trebled in price before arriving at their place of destination. The result was that goods of that kind had to be imported across the Pacific from America and England, by way of Vladivostok, to the amount of 7,000,000 rubles every year. But even this source was cut off by closing the free port by a very high tariff, so that the Siberian consumer has to do without the most necessary articles of manufacture. The great Siberian railway will therefore not only carry the metallic and other treasures of Siberia to European Russia, but also provide the Siberian population with the necessaries of life and comfort, with everything apt to make them civilized and wealthy. The extremely low figure of the Russian-Siberian trade, amounting to not more than 50,000,000 rubles yearly, will surely at once rise to a normal figure and spread evenly the products of one province to the others, do away with the

*1 pood = 34¼ English pounds.

† Mentioned under "Current Technical Literature," in this issue of the Magazine.

present anomalous condition under which the prices of certain goods vary about 300 per cent. in different provinces, and grain is sold at mock figures in one province while there is an actual famine in others.

Yet, this is not all. Russia's entire international commercial intercourse will be changed for the better. Although Russia has a very large sea-coast, yet the enormous length of the northern ice-sea is hardly of any avail for international traffic, and the Baltic is frozen at least five months during the year. The entrance to and exit from the Black sea can be easily blocked by England and Turkey in critical times. Thus it is a life question for Russia to extend the usefulness of the broad Pacific coast by connecting ways of communication and to build up in an artificial way a properly-distributed net of railroads. Although a great deal has been done in that direction, the Russian railway-system is still very scant. Only after the Crimean war did Russian statesmen begin to realize that rapid transit was a necessity for a first-rate power, especially if it was a military power. In 1891, Russia had a railway net of but 32,372 kilometers, while Germany, whose size is only a small fraction of Russia ($\frac{1}{2}\frac{1}{5}$), had more than 42,000 kilometers, not to speak of the United States, with their enormous system of railways. Nor is the net of the navigable streams sufficient for Russian commerce, these streams being navigable only in spring and autumn, the water drying out in summer and freezing during the very long winter. Besides, the Caspian sea, with only 20 per cent. of the traffic, absorbs 40 per cent. of the rivers; the Black sea, with 55 per cent. of the total Russian traffic, receives only 27 per cent. of the waterways; the Baltic, with 23 per cent. of the traffic, receives only 15 per cent. of the rivers.* In Asiatic Russia the huge streams, the Ob, Yenissey, and Lena are practically of no account except in their upper course and its tributaries. Thus, owing to the immense unconnected distances of the thinly-populated regions producing such a variety of products, these latter, as well as the products of industry,—which is limited to but 20 of the 50 provinces,—will become valuable only by a cheap, rapid distribution in all directions. To accomplish this end the construction of the great Siberian railway has been undertaken. It is also rather sure that a dislocation of the English trade will take place. At present the English are the principal mediators of commerce between Europe and Hindustan, China, and Japan. But when the Siberian railway will be able to carry the goods of all Europe, as well as of the whole east, from the western Russian boundary to Vladivostok in twelve or thirteen days, instead of six or eight weeks as it stands now, then it is surely to be expected that a large percentage of those costly exports from China,

* Some of the statistical data are taken from Mr. N. Syrkin's able article in *Vierteljahrschrift für Volkswirtschaft, Politik u. Kulturgeschichte.* Berlin: 1893.

tea and silk, will take their way to Europe by the Siberian railway instead of being shipped on English steamers via the Suez canal.

In 1890, the export from China amounted to £7,848,000 worth of silk and £6,916,000 worth of tea. Of the 24,878 tons exported from Chinese seaports, 16,098 tons—*i. e.*, more than 64 per. cent.—were shipped by English vessels. But England herself, with her rich tea-plantations in India and Ceylon, is China's most dangerous rival. Of course, England imports to Europe only so much from China as she can sell beyond the supply that can be obtained from her own colonies. Thus the tea export from China fell from 74,235,000 pounds in 1891 to 60,064,000 pounds in 1892, the deficit amounting to 14,171,000 pounds. It is perfectly safe to say that with the construction of the Siberian railway there will be a revival of the tea export from China and that all Europe will be provided with Chinese tea by that railway. And why should not also Chinese silk be exported in the same way, the freight of that light, valuable commodity being very low? Of course, a reasonable tariff system and commercial *modus vivendi* will have to be found and an equitable *do ut des* policy to be inaugurated to raise the commerce between Russia and China, which stands now at the ridiculously low figure of 18,000,000 rubles. How much Germany, France, and England will lose is self-evident, for that neighboring states with a little good will can defeat distant competitors is almost a political-economic maxim and in this special case proven by the extraordinary rise of Japanese mining and manufacturing products used in the Chinese empire.

As for the topographical and technical conditions of the great Siberian railway, I may again refer the reader to the "Industries of Russia," (Vol. V, chapter XVI.) Only so much may be said that the length of the railway will surpass our own Pacific railway from New York to San Francisco, having a length of 5500 kilometers compared with 4000 kilometers. The technical difficulties will be by far more difficult to overcome than those in the construction of the American Pacific-railway system have been, except in the case of the Canadian Pacific, which offered somewhat similar difficulties.

With the accomplishment of this stupendous work Russia will enter among those nations which give this century its brilliancy and glory for having raised the technical and commercial progress of the human race to an almost incredible standard. Two undertakings of similar dimensions are still left to be accomplished,—*i. e.*, conducting a railway through the whole length of the western hemisphere and the completion of the Panama canal. Will the glory of these two great works fall to the lot of the United States?

QUARRYING METHODS OF THE ANCIENTS.

By W. F. Durfee, M. Am. Soc. M. E.

THE methods of obtaining stone for general building purposes by the ancients have become known to us by the explorations which have been made in the early Egyptian quarries, and in what may with propriety be called stone-mines. Of the latter, the workings at Tourah and Massourah, in the Mokattan range of hills, south of Cairo, from which the whole of the limestone used in the pyramids was obtained, are good examples. These stone-mines were opened and worked in this way :

A gallery about twenty feet wide and high was run from the face of a cliff, in a carefully-selected stratum of rock (in this case a fine-grained nummulitic limestone) deep into the heart of the mountain. In driving this gallery the workmen excavated a recess or "heading" at its top, high enough for them to work in, and of the full width of the gallery, and they carried this heading far enough forward to enable them to cut a groove vertically downward behind the first block of stone that was to be taken out. While this was being done, other workmen were cutting vertical grooves on each side of the gallery from the heading to the gallery floor. At the same time a groove was cut at the level of the floor connecting the two flanking grooves. The mass of stone bounded by the three grooves and the heading was then divided into such sized blocks as was desired, the upper block being first removed, and as soon as it was out of the way the heading was pushed forward. After the entrance gallery had advanced a sufficient distance from the face of the cliff, another gallery was opened at right angles to it and extended on either hand ; and at the distance of twenty feet another gallery was driven parallel to the last, and still other galleries parallel with the first, until finally, by a rectangular system of intersecting galleries, a very large space in the interior of the mountain was converted into an enormous hall, the roof of which was supported by pillars twenty feet square, standing twenty feet apart.

The stone excavated was all removed through the entrance of the first gallery, which was often at a considerable height above the base of the cliff, a ramp having been constructed from the entrance of the workings down which the stone was dragged on sledges by men or oxen. Figure 1 is a distant view of the Mokattan range of hills over the village of Tourah, and Figure 2 is a view of the Tourah quarries seen from the mouth of a drift. The ancient quarry-men, in driving galleries, were accustomed to trim the roof to the required level, and on

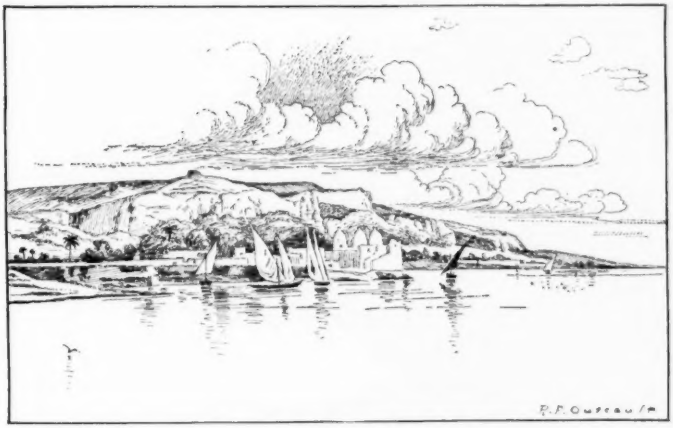


FIG. 1—DISTANT VIEW OF TOURAH.

it was then drawn a center line in red, and the sides of the gallery were then trimmed vertically in planes parallel to this center line. The open quarries of Egypt are vast *intaglios*, cut deep in the living rock by a skill whose evidences in tool-marks and drill-holes, in the selection of good materials, and the rejection of bad, remain after the lapse of more than three thousand years to excite our wonder that such achievements were possible without the aid of power-drills or explosives.

Figure 3 is a view of an angle of an ancient open quarry discovered

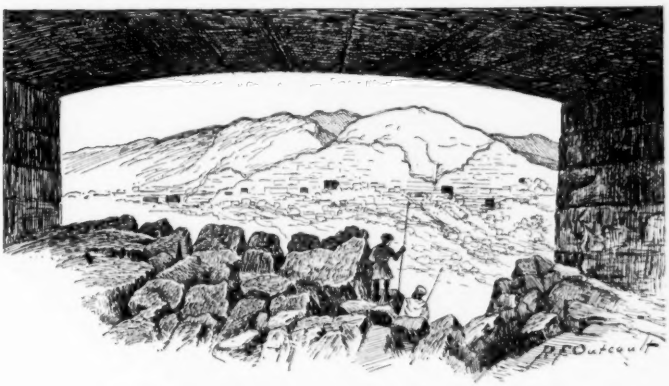


FIG. 2—QUARRIES OF TOURAH—LOOKING OUT OF A DRIFT.

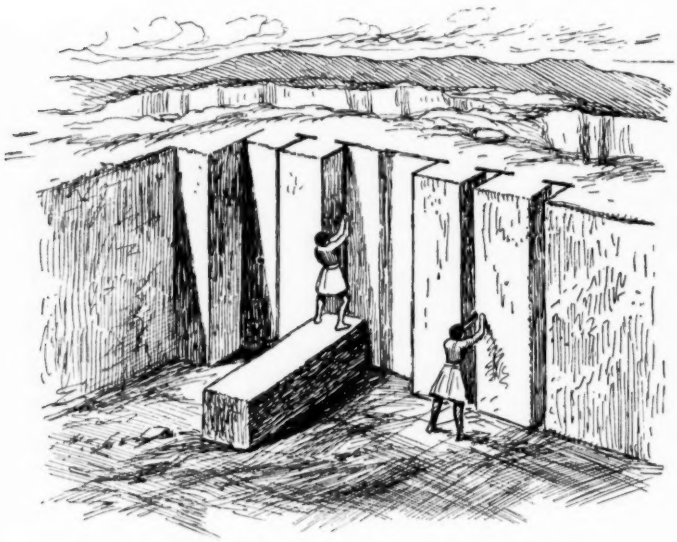


FIG. 3—ANCIENT OPEN QUARRIES NEAR JERUSALEM.

near Jerusalem and illustrates the method used by the ancients for quarrying large masses by cutting vertical grooves along their sides. Evidence of a similar method of working is seen in the quarries of Syene.

Granite in large masses was always obtained by the Egyptians from open quarries, the most famous of which were at Syene (hence the word "syenite," designating a variety of granite composed of quartz, hornblende and feldspar) in upper Egypt, near the first cataract of the Nile. The methods adopted for the horizontal quarrying of granite blocks of ordinary size was to cut a narrow groove two or three inches deep parallel with a vertical face of rock at such distance as the width of the desired stone required; in the bottom of this groove rectangular holes were made, about two inches long, one inch wide, and two inches deep; these were usually placed about four inches apart; dry wooden plugs were then driven tightly into these holes, and the spaces between them in the groove first mentioned filled with water; and the expansion of the plugs as they absorbed this water split the stone in the line of the holes. No more uniform and simple application of sufficient force for the purpose could possibly have been devised.

The Egyptian method of quarrying out an obelisk from a granite

FIG. 4—ROCK-CUT MONOLITHIC "KYLAS" TEMPLE, AT ELLORA, INDIA.

[This work is supposed to have been executed in the ninth century. The rock is granite, and the excavation or quarry in which that wonderful structure stands is about 150′ × 270′. The arrangement of the interior of the temple is quite intricate. The height is upwards of 100′.]

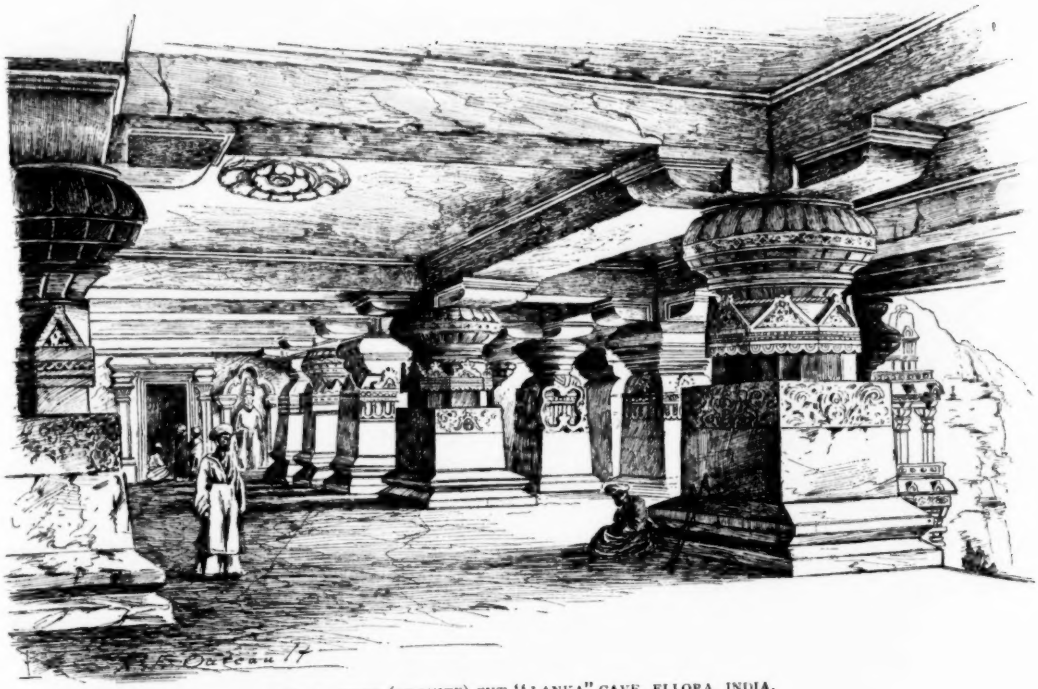


FIG. 5—ROCK (GRANITE)-CUT "LANKA" CAVE, ELLORA, INDIA.

[Date about the Tenth Century A. D.]

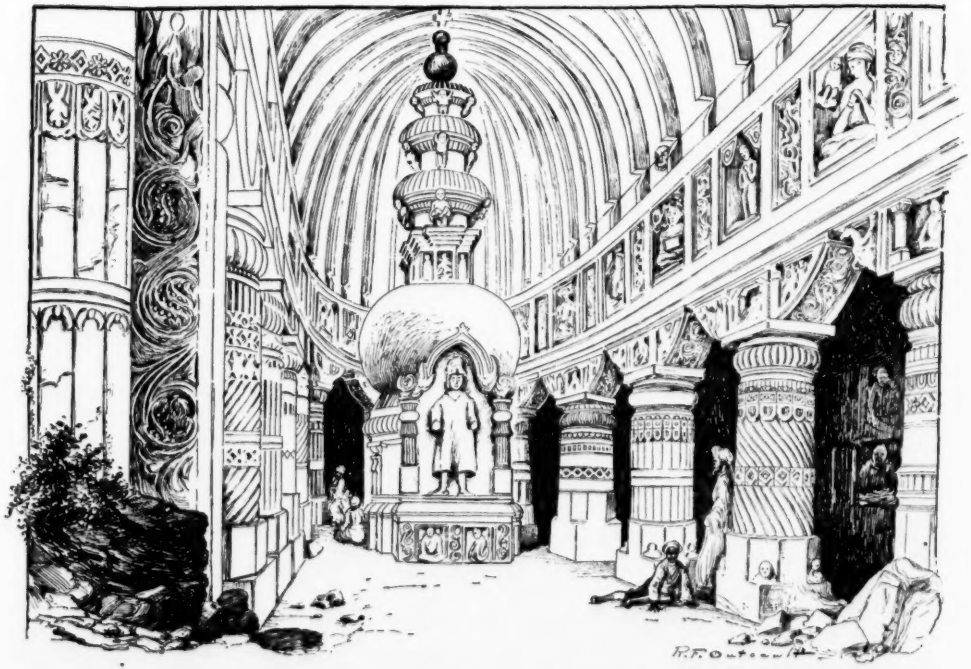


FIG. 6—BUDDHIST "CHAITYA" CAVE OR CAVE TEMPLE AT AJUNTA, INDIA—ABOUT 200 B. C.

[The dimensions are 46′ × 28′. The roof and all the details are cut out of the solid rock. On the front of the "dagoba" or shrine is cut a statue of Buddha. The cross on the roof above the shrine is not a symbolical cross, but merely an intersection of the ribs which has been made too prominent by the engraver.]

FIG. 7—GRANITE OBELISK AT SERINGAPATAM, INDIA.

[Erected in memory of Josiah Webbe, Esq., about the year 1815. All the work was done by Hindu workmen by their customary methods. At the left of the picture is shown the low timber truck on which the shaft of the obelisk was conveyed from the quarry.]

ledge is well illustrated by the enormous partially-finished monolith still remaining in the quarry at Syene. This obelisk would have been, if completed (it is still attached to the floor of the quarry), larger than any now known. According to Wilkinson it measures 95′ long and is 11′ 1½″ square at its base, and weighs 1,540,000 pounds, or 770 net tons. It was brought to its present condition by carefully excavating the rock on either side of it, dressing the sides and upper surface to their intended form, and running a groove along each side next to the floor of the quarry, preparatory to the introduction of wooden plugs for separating it from the bed-rock in the manner already stated. But these plugs have never been fashioned, and the vast mass has told the succeeding generations, for unknown thousands of years, of the technical methods of men who wrought long

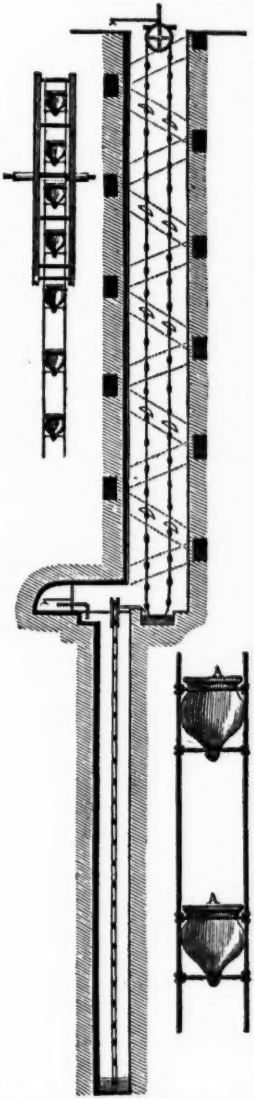
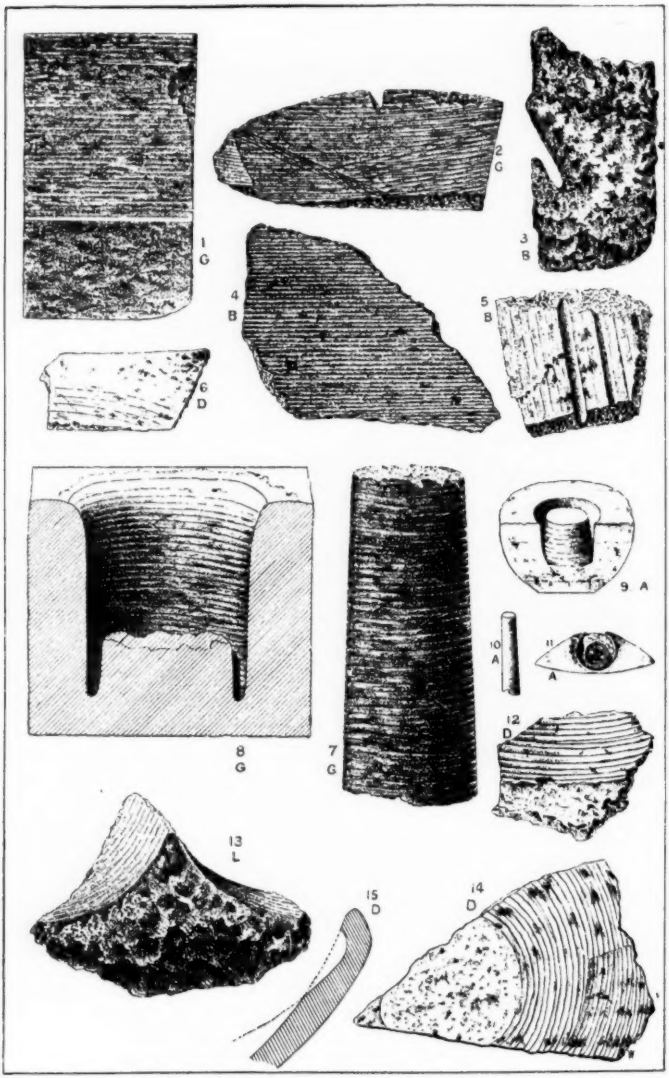


FIG. 8—JOSEPH'S WELL IN THE CITADEL AT CAIRO.

prior to the time when "Solomon's builders and Hiram's builders and stone-squarers" gave dimensions and beauty to the silently-assembled details of the grand temple of the wise king.

Hindustan abounds in examples of rock-cut or quarried temples and shrines, of which I have selected three as illustrations of the marvelous skill of the ancient Hindus in the arts of quarrying and ornamental working of stone. Figure 4 is a view of the "Kylas" temple at Ellora. This is cut out of the solid granite rock with wonderful skill and elaboration of detail. The quadrangular pit in which this temple stands has on its sides and rear end (its front being open) rock-cut colonnades and cloisters, the columns of which support the perpendicular rock above. This temple is supposed to have been quarried out to commemorate the triumph of the Sivites over the Buddhist faith. Figure 5 is another excellent example of Hindu quarrying. This rock-cut cave is in the immediate vicinity of the "Kylas," a portion of which can be seen at the right of the right hand columnar pier. Figure 6 is, according to Furgusson, "one of the most perfect, though far from being one of the most splendid, of the 'Chaitya' caves in India. In this instance every detail is cut in the solid rock, and there does not appear to have been a single wooden ornament on any part, so that we now see the cave nearly as it was left when first excavated." Similar work, though on a less elaborate plan, was executed at Petra, a rock-cut city, of Arabia Petræa, about half-way between the south end of the Dead sea and the head of the Gulf of Akabah. The rock-cut edifices in Petra are supposed to date about the second and third centuries of our era.

NOTE.—The detail at the left of the cut is the lantern wheel around which buckets traveled; at the right are shown the earthen buckets.



A. *Alabaster.* B. *Basalt.* D. *Diorite* G. *Granite.* L. *Limestone*

FIG. 9—EVIDENCES OF THE USE OF CORE DRILLS, DIAMOND SAWS, AND DIAMOND TURNING TOOLS BY THE BUILDERS OF THE PYRAMIDS.

Of the methods employed from the earliest times in Hindustan for quarrying large masses of granite, we are given an insight by the work done (entirely by native workmen) in the erection of an obelisk at Seringapatam in the early years of the present century. The stone quarried for this obelisk was 84′ in length, but the completed shaft was somewhat shorter, a small piece having been accidentally broken off in handling the rough stone. It was 6′ square at the base when finished, and was placed upon a plinth of a single block of granite 7′ square and 9′ high, in the top of which was formed a socket 6′ square and 3″ deep, to receive the base of the obelisk. Figure 7 is a view of this obelisk.

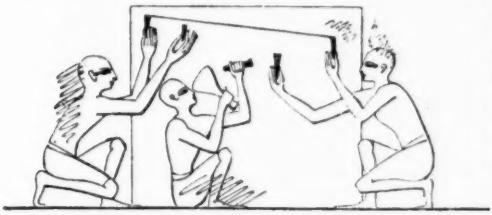


FIG. 10.

Colonel Wilkes says: "Although I anxiously watched the progress of this interesting work, I as anxiously left it to be exclusively Indian, and the design of the obelisk was the only aid afforded by any European to the native workmen."

Colonel Wilkes gives the following description of one of the methods adopted in the quarrying of granite at the quarries of Seringapatam, and states that it was used in the case of the above-named obelisk:

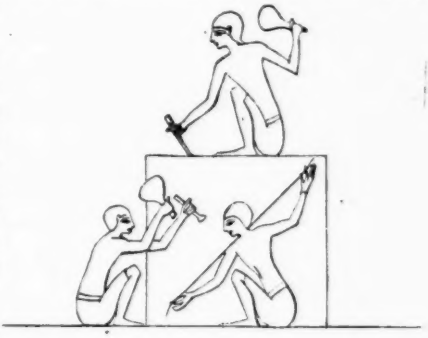


FIG. 11.

"The spot being determined, a line is marked along the direction of the intended separation, and a groove about 2″ wide and deep is cut with chisels; or, if the stratum be thin, holes of the same dimensions, at 1½′ or 2′ intervals, are cut along the line. In either case, all being ready, a workman with a small chisel is placed at each hole or interval, and with small iron mallets the line of men keep beating on the chisels, but not with violence, from left to right or from right

to left. This operation, as they say, is sometimes continued for two or three days before the separation is effected."

Sir J. F. Herschell describes another method which is sometimes used at the same quarries, but which "does not produce so clean a fracture as the first by beating. . . . The workman, having found a portion of the rock sufficiently extensive, and situated near the edge of the part already quarried, lays bare the upper surface, and marks on it a line in the direction of the intended separation, along which a groove is cut with a chisel, about a couple of inches in depth. Above this groove a narrow line of fire is then kindled and maintained till the rock below is thoroughly heated, immediately on which a line of men and women, each provided with a pot full of cold water, suddenly sweep off the ashes and pour the water into the heated groove, when the rock at once splits." This brings to mind the method attributed to Hannibal of splitting rocks during his passage of the Alps; and it has been suggested that his use of vinegar instead of water may have been found advantageous as applied to certain kinds of rocks.

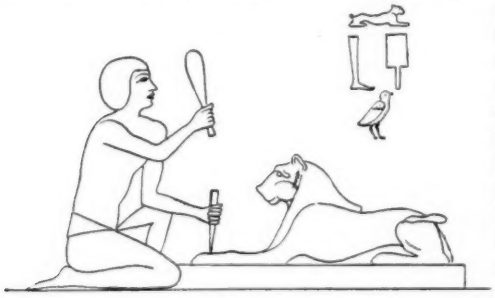


FIG. 12.

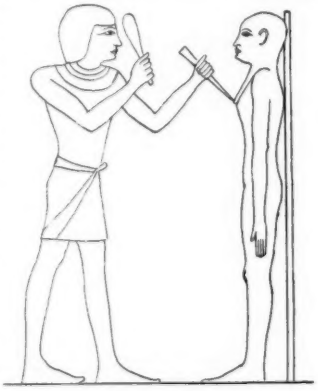


FIG. 13.

In sinking shafts in rock, the work of the ancient Egyptians is quite equal to that of any succeeding race. Perhaps the most remarkable shaft known is that of Joseph's well at Cairo, shown in an engraving on another page. The upper portion of this remarkable work is rectangular in cross-section, measuring 24′ × 18′, and is excavated of these dimensions through solid rock to the depth of 165′, at which level it is enlarged into a capacious chamber in the floor of which is formed a tank to receive the water

elevated from below. On one side of this tank, which is immediately at the bottom of the upper shaft, another shaft, 15′×9′, but not in a line with the first, is sunk 130 feet lower, where the rock ceases, and a stratum of gravel is found which furnishes the supply of water, which is raised into the tank at the bottom of the upper shaft by machinery propelled by horses or oxen working within the chamber. These animals reach this chamber by descending a series of inclined drifts which pass around the upper shaft in a manner similar to what is known as a "spiral stair." These drifts are separated from the interior of the shaft by a wall of rock not more than seven inches thick, and segmental apertures are cut through it to light the drifts from the shaft. These drifts are 6′ 4″ wide, and 7′ 2″ high. The lower shaft is also provided with an inclined path cut out of its sides and descending to the water, but there is no partition between it and the well. Figure 8 is a vertical section of this remarkable work.

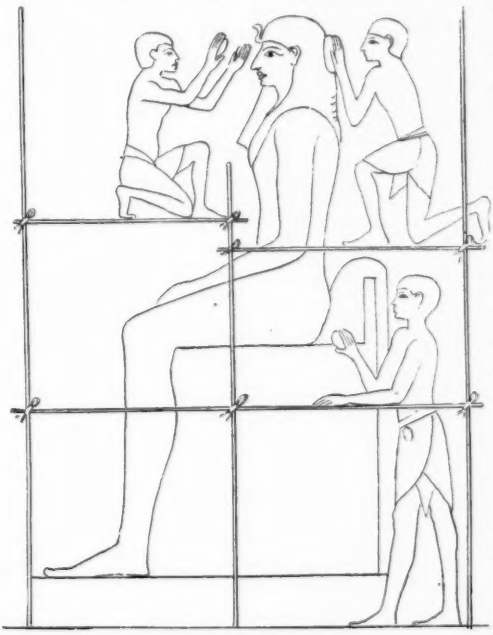


FIG. 14.

There has been a great deal of speculation relative to the means by which the Egyptian engineers carried the first shaft down, preserved the angle of the descending drifts, and maintained the uniform thickness of the thin partition separating the drifts from the shaft. Without doubt the shaft was carried downward by hand tools somewhat in advance of the drifts, and as it progressed the line of inclination of the floor and roof of the drifts was laid out on its sides, and the segmental light openings pierced; through these it was easy to remove the material from the drifts, and to transfer

the angle of the top and bottom of the drift from the lines established on the walls of the shaft. The position of the back wall of the drift could easily be accurately located parallel with the wall of the shaft by measuring through these light openings.

The tools used by the Egyptians for quarrying and stone-cutting were sometimes made of bronze and sometimes of iron. Herodotus states positively that iron tools were used in the work on the Great Pyramid, which is probably the oldest structure erected by man now remaining. In his explorations of this pyramid Colonel Howard Vyse found a thin plate of iron embedded in the mortar between two of the courses of stones, where it had undoubtedly been placed more than five thousand years ago. Among the ruins of Naucratis (600 B. C.) there were found a few years since, in what appeared to be the remains of a manufactory of iron implements, twenty-eight iron or steel chisels evidently designed for cutting stone or iron.

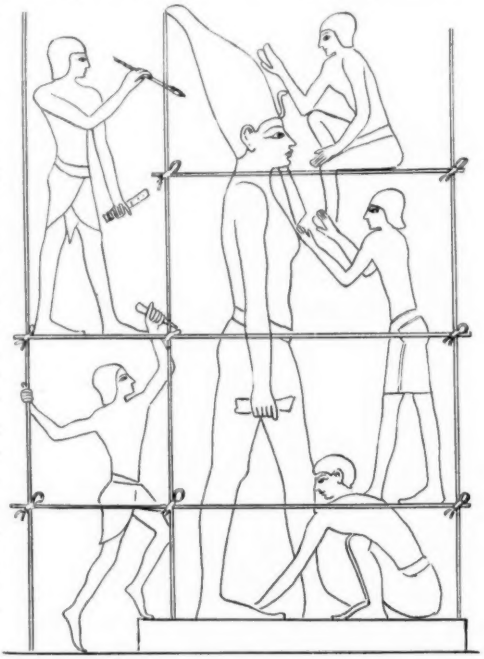


FIG. 15.

It is a singular fact that none of the very few bronze tools that have been discovered are now sufficiently hard to be used for dressing stone, and it is not at all probable that such tools were used except for the softest materials. The reason why so few steel and iron tools have been discovered is doubtless to be found in the perishable character of these metals, for unless tools made of them were placed in a position free from air and moisture, the sharp and hungry tooth of oxygen would rapidly gnaw them to destruction.

In addition to tools of iron, steel, and bronze, the early Egyptian workers in stone without doubt employed tools similar to the "diamond drills," and "diamond saws" of our day. The plate (Figure 9) taken from W. M. Flinders Petrie's work descriptive of "The Pyramids and Temples of Gizeh" exhibits some of the evidence he has discovered of the use of diamond drills and saws. It is not certain that the diamond was the jewel used to arm these implements, but it is certain that the Egyptians were acquainted with a cutting jewel far harder than quartz, and that some such jewel was used as a sharp-pointed grooving tool is placed beyond doubt by the fragments of diorite bowls with inscriptions of the fourth dynasty which were found by Mr. Petrie at Gizeh. "These inscriptions were not scraped or ground out, but were plowed through the diorite. As the lines are only $\frac{1}{1\,5\,0}$ inch wide (the figures are about $\frac{2}{1\,0}$ inch long) it is evident that the cutting-point must have been much harder than quartz, and tough enough not to splinter when so fine an edge was being employed,—probably only $\frac{1}{2\,0\,0}$ inch wide. Parallel lines are grooved only $\frac{1}{3\,0}$ inch apart from center to center."

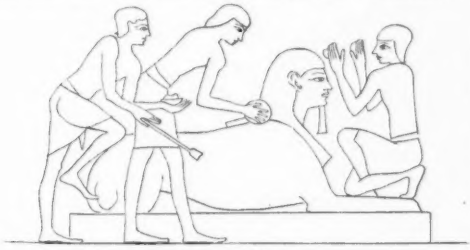


FIG. 16.

That the blades of the saws were of bronze is proved by "the green staining on the sides of the saw-cuts, and on grains of sand left in the saw-cut." The forms of the tools in which jewel cutting-points were employed "were straight saws, circular saws, tubular drills, and turning-tools for lathes." "The straight saws varied from $\frac{3}{1\,0\,0}$ to $\frac{2}{1\,0}$ inch thick." "The largest were eight feet or more in length." The examples of saw cuts shown in Figure 9 are as follows: No. 1, from the end of the Great Pyramid coffer of granite; No. 2, a piece of syenite picked up at Memphis, showing cuts on four faces, and the thickness of the saw by a cut across the top; No. 3, a piece of basalt, showing a saw cut run askew and abandoned; No. 4, another piece of basalt, showing regular and well-defined lines; No. 5, a slice of basalt sawn on both sides and nearly sawn in two; No 6, a slice of diorite bearing equidistant and regular grooves of circular arcs, parallel to one another; the only possible explanation of this piece is, that it was produced by a circular saw. The tubular drill-holes vary from $\frac{1}{4}$ inch to 5 inches in diameter, and from $\frac{1}{3\,0}$ to $\frac{1}{5}$ inch thick. The smallest hole yet found in granite is 2 inches in diameter,

all the lesser holes being in limestone or alabaster, which were probably worked merely with tubes and sand.*

The examples of tube-drilling in Figure 9 are as follows: No. 7, core in granite found at Gizeh; No. 8, section of cored drill-hole, in which the core, being of tough hornblende, could not be entirely broken out and remains to a length of $\frac{8}{10}$ inch; No. 9, alabaster mortar, broken in course of manufacture, showing core in place, found at Kom Ahmary by Professor Sayce; No. 10, the smallest core yet known, in alabaster, found at Memphis; No. 11, marble eye for inlaying, with two tube drill-holes one within another, showing the thickness of the small drills: No. 12, part of the side of a drill-hole in diorite, from Gizeh, remarkable for the depth and regularity of the grooves; No. 13, piece of limestone from Gizeh, showing how close the holes were placed for removing material by drilling; the cusp shows that the groove of one hole just overlapped that of the other. An example of tube-drilling on a large scale is found in the Great Pyramid coffer, which was hollowed out by cutting rows of tube drill-holes just meeting, and then breaking out the cores and intermediate pieces. Traces of this work may still be seen, where two drill-holes have been run too deeply into the sides. At El-Bersheh (latitude 27° 42′) there is a still larger example, where a platform of limestone rock has been dressed down, by cutting it away with tube-drills about 18 inches diameter: the cylindrical grooves intersecting prove that it was done merely to remove the rock.

The lathe appears to have been well known in the fourth dynasty (about 3600 B. C.). Diorite bowls and vases of the old kingdom are frequently met with, and show great technical skill. A piece found at Gizeh and shown in No. 14 (Figure 9) shows that the method employed was true turning: a section of this piece is shown by No. 15.

For dressing stone the "points," chisels," and "mallets" used were quite similar in shape to those employed at the present time. In Figures 10 and 11 (from tomb paintings at Thebes) stone-dressers are seen at their work. Figure 10 shows the method adopted for obtaining a surface practically flat. After working "chisel-drafts" around the

*In the early part of this century an English patent was granted to James Murdock (the inventor of the slide-valve, and chief assistant to James Watt) for a method of manufacturing water-pipes of stone. The stone of which the pipes were made was bored by means of a thin hollow cylinder of soft iron to which an alternate rotary motion was given, its lower end being copiously supplied with sand and water. In the years 1810–14 the Manchester and Salford Water Company laid water pipes of limestone (bored by Murdock's method) in the streets of Manchester. The bore of these pipes varied from three to eighteen inches, and they were made in lengths of about two feet. The prices paid for the various sizes were as follows:

3	inch bore,	4*s.* 11*d.*	per yard.	9	inch bore,	18*s.* 8*d.*	per yard.
4	" "	7*s.* 8*d.*	" "	12	" "	30*s.* 9*d.*	" "
6	" "	11*s.* 6*d.*	" "	15	" "	35*s.*	" "
7	" "	13*s.* 9*d.*	" "	18	" "	45*s.*	" "
8	" "	16*s.*					

W. F. D.

sides of the area to be dressed, the workman applied two "parallel-blocks" to the surface of the "chisel-draft" and stretched a string across the stone from the top of one "parallel-block" to the other; and then, by applying another "parallel-block" to the surface of the stone in contact with one side of the string, it was easy to note the depth to be removed. This method was employed only on vertical surfaces to avoid the error arising from the "sag" of the string if used on a horizontal side of a stone. In case a less degree of accuracy was satisfactory the string was simply stretched by the hand as shown in Figure 11. In Figures 12 and 13 Egyptian sculptors are seen using the hammer and chisel.

"Sometimes saws were used instead of 'chisel-drafts' to lay out the work; grooves were cut about half an inch deep around a block and the hammer dresser trimmed it down to the plane of the grooves. Often, in the case of sawn blocks, the surfaces to be placed in contact were roughly hammer-dressed to leave sufficient space for the cement, while just around the edges of the surface they were left quite smooth. Hence the stones would be in contact and the joints quite microscopical on the outside, while there was a fair thickness of cement on the extremely roughened surfaces inside the joint. The average thickness of the visible joints of the casing stones of the Great Pyramid was $\frac{1}{50}$ inch in 6 feet in length. The leveling of the stones was very exact, $\frac{1}{50}$ inch variation in one hundred square feet area, and a like amount in 40-feet length of joint was the largest noted. Surface plates were used, smeared with red ocher paint, and when the stones were too large for the plates diagonal drafts or saw-cuts were run." "On the sides of the forty-three granite beams (averaging fifty tons weight each) which roof the King's Chamber, and the spaces above that [in the Great Pyramid] the workmen's lines may be seen marked in red about half an inch wide; there are usually (1) a line at some definite distance from the dressed face, from which the dressing was gaged; (2) a mid-line at half the length of the beam; (3) a line near each end showing where it should be placed upon the supporting walls; (4) a line one cubit from each end, by which the lines of support could be measured off in case they were defaced; (5) small lines in black about $\frac{1}{10}$ inch wide marked on the red in some parts, to give more definite points of reference." "In lining a rock tomb with fine stone, each course was not gaged to a uniform height before it was built in; but after laying it a red line at the level of the lowest stone was run round the course to mark where the dressing down was to be done."

In India a peculiar hammer and chisel seem to have been used, the hammer being quite different from the wooden mallet employed by the

ancient Egyptians. Alexander Kennedy, Esq., states * that "the only tools which they [the Indian stone-dressers] employ are a small steel chisel and an iron mallet. The chisel is short, probably not longer than twice the breadth of the small hands which work it. The chisel tapers to a round point like that of a drawing pencil, and this I believe to be the only shape given to the points of their chisels. The mallet I have seen is of iron. It is somewhat longer than the chisel; its weight cannot exceed a few pounds. The head, set on at right angles to the handle, may be from two to three inches long. It has only one striking face. The striking face is formed into a deep hollow which is lined with lead. Having with these two instruments only brought the stone to a smooth surface, it next undergoes the dressing with water in the usual manner with masons. It now only remains to apply the black shining polish, which is done as follows: A block of granite of considerable size is rudely fashioned into the shape of the end of a large pestle, the lower face is hollowed out into a cavity, and this is filled with a mass composed of powdered corundum stone mixed with bees-wax. This block is moved by means of two sticks, or pieces of bamboo placed on each side of its neck, and bound together by cords twisted and tightened by sticks. The weight of the whole is as much as two workmen can easily manage. They seat themselves upon or close to the stone they are to polish, and, by moving the block backwards and forwards between them, the polish is given by the friction of the mass of wax and corundum." In Figures 14, 15, and 16 workmen are seen putting the final polish on the work of the sculptor by the use of hand rubbers and polishing blocks.

Relative to the means taken by the native workmen to insure the horizontality of the bottom of the socket in the plinth of the Seringapatam obelisk, Colonel Wilkes says: "I was satisfied with the means taken for insuring a true horizontal surface for the base of the shaft; but its stability entirely depended on equal accuracy in the surface of its receptacle: and, seeing no mode by which, with their rude instruments this object was to be attained, I so far departed from my first intention as to offer them a spirit-level and instructions for its use. They quickly understood and admired the contrivance, but were afraid of venturing on new methods; their own was (as they affirmed) more slow but equally certain, and they invited me to inspect it. The surface was rubbed clean and dry, and some water was dropped on it; the water ran! "*You see*" (said the engineer) "*the high* and the *low*." He dried up the water and applied the chisel to the higher portion of the surface, and, by the patience and perseverance of several days, the surface was perfectly polished, and a drop of water remained

* Paper read before the Royal Society of Edinburgh, February 14, 1821.

stationary wherever it was placed." "The whole obelisk received a very fair degree of polish from *corundum*. A piece of plank is overspread with the sort of cement used for setting sword-blades in their handles; whilst this substance is still liquid it is mixed and powdered over with pulverized *corundum* (reduced to a coarse or fine sand according to the purpose for which it is intended) and then left to dry in the sun. These planks, weighted over, are then used like the slabs of the stone polisher in England."

Much more of interest might be said, but the boundaries of our limited space have already been passed, and I am admonished to forbear; and as I relinquish my pen I am reminded that with all their technical skill the ancient delvers never—so far as we are at present advised—attempted to quarry a magazine article out of history, and have it fill with precision the allotted space.

NOTE.—The principal works consulted in the preparation of this paper were:

Wilkinson's Manners and Customs of the Ancient Egyptians.
Perrot and Chipieh's History of Art in Ancient Egypt.
George Rawlinson's Five Great Monarchies.
Ewbanks's Hydraulics.
Transactions of the Royal Society of Edinburgh (1821.)
W. M. Flinders Petrie's Pyramids and Temples of Gizeh.
W. M. Flinders Petrie's Naucratis.

W. F. D.

ART IN THE FLOOR-PLAN OF A BUILDING.

By Thomas Hastings.

THERE seem to be two mistaken tendencies in our American methods of architectural education: on the one hand, to teach architects in a scientific or literary way; on the other hand, to teach with an absolute disregard for the proper and legitimate methods of work and study in our art, as if these methods were inartistic. Our methods of study should be as peculiar to us as those of the sculptor, painter, and musician are to them.

The one class of men with whom we have to contend includes those who would dispense with the triangle, compass, and T-square, and with such familiarity with the orders and with the principles of composition as will enable the student to use them with the utmost facility. They neglect these things, forsooth, to make room for what they call clever sketching. These men seem to have a peculiar disdain for the legitimate means of study, as though they were inartistic. The other class of men, the pretended *savants*, would learn their profession as though a good knowledge of the history and literature of their art, with a course of general lectures, were all-sufficient if followed by a few years of practical office experience. To the so-called *savants*, or the men who would teach architecture only in scientific or literary ways, it should be said that architecture is an art rather than a science, and that when the architect is most skilled in his art, then he has least need of recourse to science. Of course, an architect must be familiar with descriptive mathematics, for the purpose of calculating the intersection of vaults, roofs, and various problems in stereoptomy. Yet, if the floor-plan has been well studied from an artistic or esthetic point of view, there will rarely be left other difficult engineering and mathematical problems for the architect to solve. Here is the key to the entire problem.

I shall first endeavor to make clear the fact that there is such a thing as art in the floor-plan. There seem to be few architects in America who realize that the floor-plan is anything more than a mere matter of the convenient arrangement of the several parts of the building. A good floor-plan, as seen on paper and before examining into the questions of arrangement, has proportion form, scale, color, values, and character. The drawing of the plan will awaken as much enthusiasm in the educated architect as does the picture in the painter, or the statue in the sculptor. This plan should be thoroughly studied and practically finished before the architect has more than a vague idea of

the design of the exterior of the building. The plan involves and determines the entire composition; the silhouette or outline of the whole structure is really projected on the plane of this drawing,—*i. e.*, the thickest walls and the heaviest piers are the portions of the outline of the building which go the highest, for the silhouette is the necessary outcome of the artistic relations of these different wall- and pier-thicknesses to each other. We know that when a pier is five feet square in plan, whether it is the foundation of a tower or the foundation of one of the corners of a dome, it must go higher than the wall next to it, which is only two feet thick. The relations of the wall to the pier must look well on paper. If the proportions and the relations of the walls to each other are good, the silhouette will prove to be good when seen in perspective after the building is complete.

The floor plan determines the entire composition, and it does away with the perspective drawing as a help to architectural study and leaves it no place except to explain a building to a layman. It is amateur-like to use the perspective for any other purpose. When the plan is well studied, then it constructs well and builds well, and we need very little of the analytical mathematics to assist us in our construction.

Until modern times, how much mathematics (besides geometry and the descriptives) did architects know, as compared with what we are given to learn, and what did they know of the strength of materials? With them it was mostly a question of good judgment, with a proper and uncommon understanding of constructive principles, and of stereoptomy and the other descriptive mathematics Analytical mathematics is comparatively a modern science. While, for example, there existed graphical rules for the approximate determination of the thrusts from arches as early as the thirteenth century, yet it is practically only within the past fifty years that the correct principles of analysis have been fully developed, and there is still room for improvement in this direction. Until recently architects probably never calculated the strength of their materials, or the thrust of arches and vaults. With them it was a question of intelligence, and not of ingenuity. It was the qualitative, rather than the quantitative, principles of construction that they studied, and these always based upon experiment or experience. It was by knowing how to avoid difficult problems *with art* in the floor-plan that they escaped having difficult analytical problems to solve. We must always give precedence to practice and truth before laws and theories.

To illustrate this principle, there may be many arches indicated in a well-studied plan, but the thrust of each is received, either by an equivalent thrust in the opposite direction or by a solid masonry wall, in line with the direction of the force, to buttress the arch.

In a well-studied floor-plan there will always be artistic reasons for

making a pier economical in size and strong enough to support the weight that it has to carry. By pure mathematics we can only approximately determine what should be the size of a pier. The strength of materials must be estimated. We select at random several specimens of the stone to be used in our building. We obtain crucial tests from a machine designed for this purpose, and so we are supposed to learn from these few specimens the average weight per cubic inch which the stone will support. This we call our coefficient of strength in the stone chosen for our building. Taking into the account the fact that the quarry where the stone is obtained may have a great fissure running through it, or may have other imperfections, the mathematician enters upon his calculations to learn how large a pier built of this stone should be to support the weight that is to be above it. After this, the architect practically admits the inexactitude of his premises by increasing two or more times the size of the pier and calls this the factor of safety or ignorance. I believe in such calculations for purposes of verification, but in general the piers will be *about* as safe to build upon when studied by an educated architect as when calculated by engineers.

It is really architecture and well-proportioned masonry *versus* engineering and the iron girders. Each has its use, but they are not interchangeable. Buildings have stood for centuries, and this is solely because their plans, as seen on paper, were so well studied, so thoroughly artistic and beautiful, that constructive difficulties were avoided.

Now that photographs and illustrated books are becoming so accessible to the student, adaptation is a greater temptation to us than ever before. We compile more than we compose, but if our floor-plan is first thoroughly studied in an artistic way, to meet the practical requirements of the problem in hand, then, when interpreting this plan and designing the façade, we can neither copy nor adapt what was conceived for one thing, making it serve the purpose of another.

We must not disparage analytical mathematics for purposes of verification. So long as a great many inartistic buildings are put up, such verification is needed for the protection of human life. From innumerable buildings time makes its selection, but at the sacrifice of human life in those which fall, because the inartistic buildings were not subjected to analytical verification. But this kind of verification, especially in complicated and exceptional cases, should always be entrusted to experts or specialists. Of course there are exceptional and most unfortunate conditions imposed upon us in these days, under which conditions the plan has but a very small part to play in the solution of the problem, such as fifteen-story office-buildings on 20-foot lots.

Here all would agree that expert mathematicians and engineers should be called into consultation, just as they are called in for questions of steam-heating, ventilation, or electrical work. But with these exceptions in the well-studied floor-plan, the constructive problems solve themselves, so that we do not have to resort either to calculation or to mere ingenuity. The plan determines every perpendicular line, so that it is, in fact, almost impossible to build a structure that is absolutely unsightly, on a well-studied, well-proportioned plan. The thicknesses of walls and piers should be proportionately related to the spans of the arches, or to the distances and floor-spaces. The thickness of a column should be proportioned to the intercolumnication or distance between columns, and the whole should be looked upon almost as you would look at a drawing in black and white, the black portions of the plan indicating the walls and piers, the largest going the highest in the elevation. Therefore, the more art we have the less science we need. When a floor-plan has been thoroughly studied, then in developing the exterior or interior no changes will be needed, even in details. We shall be saved from adaptation instead of composition. In the further development of the scheme we need only fill our minds and hearts, however large, with the spirit, the ideas, and the sentiments of our age, and study and interpret the plan, in order to reach the best results. Thus art in the plan is the first great need.

In the schools where architecture is taught, in the United States, the lecture-room plays too important a part. The architect or professor who teaches does not come enough into personal contact with the student to criticise his work, and the advanced students are not enough in contact with the beginners, as is universally customary in the ateliers or the studios of Europe.

To the men who disdain these true methods of study, because they think them inartistic, I would say that we do too much mere sketching and not enough serious studying. The architect should not despise the T-square and the triangle any more than the musician should despise the key-board of his piano. Sketching plays a very minor part in architecture; yet how many architects feel, if they can make a clever sketch, that they are skilled in their profession. An architect's drawings should be looked upon only as architectural—merely as means to an end—and yet they need be none the less artistic and fascinating to the architect.

The architect should design in plan and not in perspective. The day is coming when the public and all honest critics will demand of design in architecture something more than mere taste and refinement of details; when the monument must be something more than a conglomerate of well-molded garlands, wreaths, and ribbons, well-propor-

tioned windows and columns, or the use of materials fine in texture and color,—and this can be only when the plan is looked upon as something more than merely a question of convenient arrangement, and the picturesque as something more than an eccentric accumulation of accidentals and good details.

I would not be misunderstood. I would not disparage the thorough study of the plan from a utilitarian point of view. This is in fact the principal channel through which our life and habits influence our composition and style. Before beginning to study the general composition of the floor-plan, it is first necessary to reduce the problem to its simplest form from a utilitarian point of view, taking into the account the number of the principal rooms or divisions, and the use that they are to be put to, their sizes, and the most reasonable forms that should be given to them. This is, as it were, the theorem or the program of the composition.

If the question of disposition is not thus thoroughly understood at first, it will arrest the freedom of the mind and the imagination.

Of equal importance is the question of the position or site of the building, and the principal points from which it will be seen. Certain distributions of the several parts of the building that would be well for a low and flat country would be inappropriate for a hill. The streets, promenades, or squares, or possibly water—river, lake, or sea —should of necessity have a great influence upon this distribution. The architect should know how to dispose his masses and should calculate the different effects with these conditions of environment taken into the account ; that is to say, the principal room may demand a certain outlook, and perhaps some other rooms must be seen from a given point of view. The plan which does not satisfy all such given conditions is not only impracticable, but must in consequence thereof be absolutely inartistic, for a good building must have obvious adaptations both to its uses and to its environment. These things must of necessity influence the general character of the design.

In general, it may be said that there are three kinds of floor-plans : the *regular*, the *irregular*, and the *picturesque*. A monumental floor-plan is always regular, unless the peculiarities of the site make this impossible. The regularity consists in the plans having one principal axis. The irregular plan is an adaptation to the imperatives of an irregular site. It secures as much symmetry, in the arrangement of its parts and proportions, as the limitations of the site permit. The picturesque plan is not merely eccentric or lawless, but is an attempt to conform to the picturesque conditions of the environment,—at the same time preserving as much of balance and symmetry in the details as such adaptation will allow.

The general form may be as irregular or unbalanced as the letter L, and yet have perfect symmetry and circulation such as will give interesting vistas in every direction. The general principles of composition are the same as in the case of a regular plan.

Having considered the plans of buildings, we come now to speak briefly of the plans of the immediate surroundings, which the French call "*the plan generale.*" They have a very characteristic name for this portion of the composition, which is the "sauce of the architecture." It is this portion of the design which unites or marries the building with its natural surroundings or the landscape. Most of the same principles of composition obtain in the planning of this portion of the work, as in the planning of the building itself. The silhouette must make first of all an agreeable ensemble with the silhouette of the building. If the surroundings will allow it, the building should be so placed as to have the greater portion of the grounds on one side of it. This is generally very desirable, and especially when the site is small in proportion to the size of the building. The object is to give a large and open space on this one side, instead of a small frame or fringe all the way around it. This is not only true in the case of a public building, but it is just as true in the case of a dwelling. It would seem as though this were a mere question of common sense, and yet how little the principle is recognized; how dreary are the suburban homes of the poorer classes in this country. It is mainly because a man, when he builds, places his small square house in the center of a square lot, with a square walk around the house, and a fence that forms a square around the walk, and, as though this were not enough, even the streets all form squares outside his lot.

While the landscape or surroundings should govern the general composition of the building in the beginning, the building should in turn, when completed, influence and govern the arrangement and composition of that portion of the landscape work which comes in immediate contact with it. This landscape work is to surround and to support the building, serving both as frame and as pedestal. The accessories of the architecture, such as the terraces, balustrades, paths, fountains, open spaces and vistas which come nearest to the building, and other architectural features, are really a part of the building.

While the plan of the surroundings does not need to repeat the form of the building itself, it should everywhere recall its principal axes and lines, and it should accentuate its general silhouette, just as where there is a pavilion or important feature in the building there should be a circulation in the surroundings leading up to it.

Fountains, balustrades, statues, and rows of trees, when desired, should be clearly indicated in plan. All these things, with the plan

of the building itself, should hold together in one great ensemble, while there may be interesting detail in the form of niches in the verdure for statues, or recesses for seats or vases, and small round or square breaks taken off the angles where two paths meet. All these forms should be studied in almost exactly the same way as if they were in the plan of the building itself. A statue should rarely be placed in the middle of a lawn, but either in a recess or in the center of a square at the intersection of an axis with the circulations. The size of the statue, as represented by its pedestal, has a proper relation to the other surroundings and to the plan of the building. A statue generally looks better in a public square with an architectural background or in a formal garden in a recess on either side of a main avenue, with thick foliage behind it, instead of standing against an open sky. Generally speaking, therefore, it is best to keep statues out of the large parks which are more apt to be naturalistic, and put them in the small parks.

Something should be said with reference to the general plan of cities; that is, the laying out of streets, avenues, or parks.

The planning of a city is rather an evolution in history than the work of an architect, and so gives valuable testimony to the different phases of the life of the people. Many of the most interesting souvenirs of the past are seen not only in the buildings and monuments, but also in the general disposition of the streets and public squares. How much art, however, may be displayed in the influencing of this evolution can be seen by looking briefly at some of the cities of modern times. The greater portion of every city is the result of the accumulated works of generation after generation. This development is determined by local circumstances, by the political constitution, and by the commercial and domestic life of the inhabitants.

But happy is the city whose development in the cutting of new avenues and the building of new squares and parks has been governed by the laws of art. In a general way, the cities which have most impressed us are those that have at least one great artery running through the interesting confusion and natural complication of its streets. For example, how much more lasting is our impression of Paris than of London. When we think of Paris, we first see that one main artery, with which we associate the great composition spread out before us when standing on the Place de la Concorde. On one side are the garden of the Tuilleries and the court of the Palace of the Louvre. In front of us is the magnificent avenue of the Champs Elysée, which terminates with one of the greatest triumphal arches ever built. To the south is the river Seine, and the beautiful bridge leading to the monumental portico of the palace of the Corps Legislatif. To the north, those two most splended buildings of simple and vigorous proportions, the Garde

Meuble, and between these the vista of that wide avenue leading to the façade of the Madeleine. In the center of the Place de la Concorde is an Egyptian obelisk ; in the axis of the main circulation there is a large fountain, on either side and in axis with small circulations from the corners of the square ; in different parts of the composition are colossal statues and a multitude of candelabra. All these things enter into the composition of what I would call the main artery of the heart of the city—one of the greatest plans that the world has ever seen. All this is in striking and interesting contrast with the rest of the city, which is so complicated that it seems utterly devoid of any plan and to be the result of mere accident. And yet all this confusing complication is the outcome of most serious consideration in the history of the city.

What impressions to compare with this have we of London, where almost all seems to be confusion, and what is our impression of New York as to its general scheme, where there is no interest either of contrast or of confusion? Rather the greater part of the city is laid out in monotonous squares like a checker-board, without any street or avenue leading up to any monument or other object of interest, and with the circulation in only two directions. It does seem that every modern city might have one great artery or central avenue, and as though it might be possible to avoid prolonging streets to an indefinite length without leading up to anything.

The New York municipal government has now in hand a most interesting opportunity to display artistic skill, and to illustrate some of these principles, by the selection of a site for the new city hall. Instead of crowding a small park or open space with a large building which would be entirely out of scale with its approach or surroundings, they should select a site in an inexpensive neighborhood, which should be near enough to Broadway to allow of the widening of a cross-street to lead up to the center of the building, as was done in the case of the Rue Sufflot in Paris, which leads up to the Pantheon, thus making the widened cross-street a short avenue of approach to the central motive of the building. This building would soon change and determine the character of its surroundings, and so increase the value of adjoining property.

Thus it may be seen that the same principles which apply to the most unimportant plan apply also to the monumental building, and to the general plan of its surroundings, as well as to the cutting of streets and the laying out of a city.

COMMERCIAL RELATIONS BETWEEN CUBA AND THE UNITED STATES.

By E. Sherman Gould, M. Am. Soc. C. E.

IN treating of the commercial relations of Cuba with the United States, we are confronted at the very outset by a serious difficulty in the shape of the scarcity of trustworthy statistics. The mathematics of the question is wanting. In order that this statement may not rest solely upon my individual assertion, I quote from the report for the year 1892 of the British consul-general at Havana, to his government, upon the trade of the island: "The difficulty of obtaining the necessary data upon which to frame anything like a comprehensive and accurate commercial report for this island is almost insuperable. I have met with similar difficulty in other Spanish countries, but never quite to the extent that I have encountered in Havana. No official statistics are published." In spite of this obstacle, much light may be thrown upon the subject by treating it in a general way, qualitatively as it were, and not quantitatively. Such is the object of this paper.

The island of Cuba is about 720 miles long, with an average width of sixty miles, containing thus some 43,200 square miles.* Its population is generally assumed at 1,500,000, of which about one-seventh is concentrated in the city of Havana and its vicinity.

The table on the following page, showing the amount of merchandise exported from Cuba during the calendar year 1892, is taken from the above-quoted report of the British consul-general, who gives it as probably approximately correct.

This table shows that Cuba is a country of practically two products (sugar and tobacco) and of one market (the United States). Indeed, we may almost say that it is a country of *one* product, so greatly does sugar outweigh in value the tobacco production. The same report states that nine-tenths of the entire amount of sugar exported goes to the United States.

In order to show the immense importance of Cuba as a sugar-producing territory, I give further on a table prepared for two years, by Messrs. H. Clark & Co., of Liverpool, with an additional column—the third—from *L'Economiste Français*.

* See an article entitled "Business Opportunities in Cuba," by Mr. Eduardo J. Chibas, in the November (1892) number of THE ENGINEERING MAGAZINE.

STATEMENT OF EXPORTS OF THE PRINCIPAL ARTICLES OF CUBAN PRODUCE IN 1892.

Destination.	Sugars.		Refined Sugars.		Molasses.	Honey.	Wax.	Rum.	Cigars.	Tobacco.	Cigarettes.	Scrap.
	Bags.	Hogsh'ds.	Barrels.	Boxes.	Hogsh'ds.	Tcs.	Arrobas.	Pipes.	Thousands.	Lbs.	Packages.	Kilos.
United Kingdom.	.....	.....	.....	.....	.....	.....	.....	221	42,594	285	.....	.....
Holland	.....	.....	.....	.....	.....	50	.....	36	20	573	.....	.....
Germany.	.....	.....	.....	.....	.....	655	.....	.....	18,419	33,837	260,950	230
Belgium	.....	.....	.....	.....	.....	50	.....	.....	810	547	.....	.....
France.	1	.....	.....	2	12	1,146	1,492	1,734	7,816	2,149	2,391,026	18,577
Spain & Canaries.	328,521	.....	1,785	6,523	1,081	104	8,967	17,103	11,856	30,578	3,399,142	21,234
United States ...	1,154,193	6,995	.....	.....	6,544	254	2,486	162	81,512	176,086	7,979,199	80,712
Canada	2,500	.....	.....	.....	.....	.....	.....	.....	257	.....	4	100
Mexico & Guatemala	.....	.....	.....	.....	.....	.....	40	13	89	.....	5,078,306	32
P to Rico & Hayti	.....	.....	.....	.....	.....	.....	60	.....	915	50	17,553,658	364
South and Central America.....	10	.....	.....	5	.....	.....	12	1,972	2,424	201	5,878,468	182,948
Total.....	1,485,225	6,995	1,785	6,530	7,637	2,259	13,057	21,241	166,712	244,306	42,540,753	304,197

This second table shows that, between 1891 and 1894, Cuba furnished one-third of the entire cane-sugar production of the world. Taken in connection with preceding statements, it also shows the immense sugar-consuming power of the United States. Not, however, that the whole of the great quantity imported by the United States is consumed there; no doubt much of it is reëxported in different forms, a certain quantity finding its way back to Cuba in the shape of "sweet goods."

It may be said, therefore, that the entire commercial existence of the island is dependent upon sugar. On the other hand, the cultivation of the cane, the grinding of it, the treatment of the juice, and the necessary transportation require a vast amount of machinery, implements, rails, and locomotives and other rolling-stock. Since Cuba has no such manufactures, all this material must come from abroad, and naturally much should come from the United States.

RETURN OF THE WORLD'S PRODUCTION OF CANE-SUGAR.

Countries.	Quantity in Tons.		
	1891-92.	1892-93.	1893-94.
Cuba	920,000	900,000	1,000,000
Puerto Rico	60,000	65,000	70,000
Trinidad	50,000	55,000	55,000
Barbadoes	60,000	70,000	65,000
Jamaica	30,000	30,000	35,000
Lesser Antilles	90,000	90,000	30,000
Martinique	25,000	35,000	35,000
Guadaloupe	55,000	55,000	50,000
Demerara	100,000	120,000	110,000
Réunion	40,000	35,000	40,000
Mauritius	114,000	80,000	150,000
Java	435,000	430,000	500,000
Brazil	185,000	200,000	230,000
Philipines	245,000	250,000	230,000
United States	170,000	200,000	240,000
Peru	37,000	45,000	60,000
Egypt	55,000	65,000	80,000
Sandwich Islands	135,000	125,000	130,000
Total	2,806,000	2,850,000	3,110,000

The value of the sugar exported from Cuba to the United States has no doubt frequently reached, if not surpassed, the sum of $60,000,000 in a single year. At any rate, it will be surely safe to estimate the total yearly value of all exports from Cuba to this country at that figure. This large sum must be paid back to Cuba either in money or in the exchange of commodities. In regard to this alternative we must recall the fact that Cuba has no manufactures of any account except cigars; that all the implements and machinery used in sugar-making and all the textile fabrics used for clothing, and even many articles of food, such as breadstuffs, butter, salt meats, and "canned goods," must come from abroad. That is to say, $60,000,000 worth of exports are sent by a country without manufactures to the greatest manufacturing country in the world, and one in which the danger of "over-production" is supposed to be a standing menace. Under these circumstances the mere statement of the question, "How should these imports be paid for?" carries its answer with it.

In this connection the following table, compiled from the records of the United States treasury at Washington, and showing the total value of exports from the United States to Cuba for two different years, will be of great interest, especially as it gives an idea of the varied character of American products which already find a market in the latter country.

This table shows that the balance of trade is largely against us, assuming our imports from Cuba to reach $60,000,000. There is evidently room in the island for at least thirty millions more of

American goods. The table shows also that about one-half of the value of our exports in 1893 consisted of breadstuffs, provisions, etc., while wood and wood-work amounted to about one-eighth, and coal, iron, hardware, and machinery entered the list for about a quarter of the total amount.

VALUE OF EXPORTS FROM THE UNITED STATES TO CUBA IN 1889-93.

DESCRIPTION.	1889.	1893.
Agricultural implements	$ 74,135	$ 130,341
Animals	14,264	39,401
Books	46,617	39,075
Brass manufactures	32,420	44,150
Breadstuffs	1,336,147	3,511,617
Bricks	4,922	95,489
Builders' hardware	80,285	395,464
Carriages	67,282	316,045
Car-wheels	1,908	18,073
Chemicals	223,784	386,562
Clocks and watches	17,399	26,551
Coal	581,094	931,571
Copper manufactures	13,692	48,656
Cotton manufactures	126,180	148,178
Cutlery	10,347	21,094
Firearms	3,030	3,055
Flax, hemp, and jute	301,290	86,478
Fruit	30,971	126,954
Glass	55,178	117,870
India-rubber goods	27,804	42,879
Iron manufactures, not otherwise specified	241,122	1,343,551
Lamp goods	28,326	51,389
Leather manufactures	166,334	181,476
Lime and cement	16,500	71,570
Machinery	965,242	2,792,050
Marble and stone	14,243	77,003
Nails and spikes	58,112	127,583
Oils	430,203	548,092
Paper	198,461	159,895
Provisions	3,267,883	5,611,076
Railway bars	20,240	327,411
Railway-cars	127,533	271,571
Saws and tools	115,232	243,544
Scales and balances	35,406	62,561
Sewing-machines	42,571	95,630
Steam-engines	10,493	130,652
Sugar and candy	19,941	35,911
Tobacco, manufactured	59,658	61,494
Vegetables	380,802	978,261
Wire	118,214	321,120
Wood and manufactures of	1,110,946	2,881,095
All other	820,987	701,656
Total	$11,297,198	$23,604,094

It is the wish of the editor of this Magazine, as well as my own, that the present paper should be written without the introduction of any political feature, but it is impossible to avoid all mention of the reciprocity treaty, if anything like completeness is aimed at. In regard to this point it will be most satisfactory both to the writer and to his readers to refer the matter to an outside judgment. I will therefore quote from the British consular report, already referred to. After speaking of the difficulty of obtaining trustworthy statistics, the report says :

> It will be seen from the above article that the difficulty—especially to a newcomer—of forming anything like a clear and accurate view of the commercial movement of the district is next door to impossible. But, unfortunately, there is one feature of a very unsatisfactory nature, which stands out prominently and did not take long to discover, namely, that British trade with Cuba has almost become a thing of the past; and under the recent reciprocity treaty the United States of America practically supplies all the wants of the island and receives all its produce. . . .
>
> Machinery, which formerly was largely supplied by England, Germany, France, and Belgium, now nearly all comes from the United States; and the machinery required for the vast amount of sugar manufactured in Cuba is immense and of great value. . . . .
>
> The reciprocity treaty between Spain and the United States would appear to be mainly beneficial to the latter nation. Articles such as machinery, iron, steel, coal, etc., which formerly came principally from Europe, and continue to pay duty when imported from those countries, are admitted free of duty when coming from America, so that the former trade is fast disappearing, although some articles of English manufacture and of superior quality are still able to compete, notwithstanding the duty. The free admission of flour makes bread cheaper, but this is the only article which seems reduced in price. The free admission of Cuban sugar into the large markets of the United States is, of course, the great inducement for Spain to enter into an arrangement by which she sacrificed a considerable portion of her customs revenue. . . .
>
> The effect of the recent reciprocity treaty between the United States and Spain in regard to her West Indian colonies has been to throw nearly the entire Cuban trade into the hands of the United States traders, with whom importers of goods from less favored nations cannot compete, having to pay, by the terms of such a treaty, higher import duties.

The Western of Cuba railway, now in English hands, and recently extended from Havana to Pinar del Rio, in the heart of the finest tobacco region of the island, has called largely upon the United States for its new work. Many hundred feet of iron bridging were furnished and erected by the Union Bridge Company of New York, the railway company being satisfied with the price, and their engineer, as well as the government inspectors, satisfied with the work. The cement used was also wholly or largely American, the American being adopted rather than the English, somewhat reluctantly by their engineer, on account of the greatly reduced cost. The stone used for bridge-seats was American granite, and highly praised to me by the engineer, who, being a Scotchman, was naturally a good judge of the material.

The fact merits attention, in estimating the value of the Cuban market, that the people are heavy buyers. There is very little saving practised. I do not think there is a single savings-bank on the island. A friend of mine, Captain Justiz, of the regular Spanish army, has recently organized a coöperative society among his fellow-officers with results which so far, I believe, are satisfactory, and a savings-bank in the same connection has been spoken of, but the organization of this society is the only step that I know of having been taken in the way of intelligent economical measures. As a rule, all money received is freely spent, particularly by the poorer and middle classes, who, of course, form the bulk of the population. Probably the pernicious system of government lotteries has something to do with the absence of saving, as the practice of purchasing tickets is as widespread among the poor as it is destructive and demoralizing. Probably, too, the character of the climate and the consequent ease of living prevent people from devoting much forethought to a future that they do not dread, for there is really very little of that pinching want ever felt in Cuba which recent hard times have brought to notice in our own country. Be the cause what it may, the fact remains that all the Cubans are prodigal in their expenditures, which goes far to account for the immense quantities of goods consumed and paid for by a comparatively small population.

Enough has been said, I think, to show that Cuba offers a most inviting field for American enterprise. Her prosperity and even her very existence may be said to depend upon her commercial relations with the United States; the two are bound together by the strong ties of mutual interest, and everything points to the fact that, commercially, Cuba should be ours, and this is the only kind of possession of the island, be it said in passing, that at present would suit either Spain, Cuba, or the United States. We want no other conquest of Cuba than a commercial one, and such peaceful conquest would be of common benefit to the three parties most concerned, and, I think, to all the world. I believe that if the trade, not only of Cuba, but also of all the South American countries, were first poured into the United States as a receiving reservoir, it would be naturally distributed, directly or indirectly, over the world to better advantage than if distant and various nations were carrying on desultory and independent business relations with them. The purchasing power that would be gathered into and concentrated in the United States by such trade would be largely expended in procuring those requirements of an ever-advancing refinement and civilization which Europe can at present, at least, furnish better than we can ourselves. We appreciate and want these things—none more so—and the wealth which a practical monopoly of the

South American trade would give us would make us Europe's best customer for those things of which she is the best producer. But this is a digression.

The Cuban market, like all others, is governed largely by fashion. Hitherto all supplies, except perhaps locomotives and steam-boilers, which have for a long time been chiefly furnished by the United States, have come for the greater part from Europe. I think that both in Spain and in South America French goods, as well as French manners and customs, have the preference. Just as there is a certain tendency in the United States to admire and imitate that which is derived from English sources, so everything French is apt to "go" in these countries. It naturally takes time to overcome such preoccupations, particularly as in many cases they are well founded. I have taken occasion elsewhere to call attention to the fact that American houses shipping goods to Cuba put themselves under a quite unnecessary disadvantage by careless packing. In the case of many fancy articles the mere appearance of the package goes a great way, and in the case of all goods careless packing entails great loss from breakage. This loss is a two-fold one for the American dealer. Not only does he have to make good the damage at his own cost, but he creates a prejudice against his goods and his ways of doing business. This brings up another important point. It is a great mistake to suppose that "anything is good enough for Cuba." On the contrary, the people there not only want the best, but they also know it when they see it, and, once deceived, they never have any further transactions with the deceiver. The market is perhaps a capricious one, but it is one that fully recognizes and appreciates fair dealing, and there is no better or more paying advertisement than to enter it "on the square."

The market being such as it is, and, moreover, being for many classes of goods a new one, the agents employed in it should be carefully selected. Here, again, Americans are at a disadvantage. Very few of the commercial travelers who are sent out from the United States speak Spanish, whereas nearly all those representing foreign concerns do. The Americans are therefore obliged to put themselves entirely into the hands of agents and interpreters, which is always an unsatisfactory way of doing business. In view of the growing relations between the United States and the South American countries, it would seem as if Spanish should occupy a preferential place, in our educational institutions, over the French or the German. Our business is to invade the Spanish-speaking territories, whereas we are ourselves invaded by the European nations, and this fact necessitates a more perfect equipment on the part of our business agents entering the foreign field.

As regards the classes of goods most needed in Cuba it would be impossible and wholly unnecessary to particularize more fully in this paper. We may broadly say that everything needed in this country is needed in Cuba, within the limits imposed by the difference of climate. They want or can be led to want everything we can furnish, that is good and cheap.

I may perhaps be here permitted another digression. We have heard a great deal in times past, and more particularly of late, of "over-production," and it is supposed to account for many of our business troubles. Now, over-production is a strictly relative condition, and its remedy is either to produce less or to dispose of more. Political economists tell us that true material progress lies in commonizing the good things of life, so that what to-day are the luxuries of the rich, shall become to-morrow the ordinary possessions of the middle classes, who will in their turn relegate their previous simple comforts to the poor, thus establishing an ever-ascending scale of prosperity, and raising, as it were, the standard of poverty. It is impossible, I think, to deny the truth of this proposition, which dictates a *leveling up*, instead of the socialistic plan of *leveling down*. In this view it is plainly to be seen that we are not, and cannot be, in any danger from *over-production*. What we and all the world are suffering from is *under-distribution*. The remedy, as far as the United States are concerned, is not to limit production, but rather to increase it even to its utmost possibilities and then launch out in quest of new markets. It is this policy which has given England her vast commercial supremacy in the past. She has never attempted to restrict the production of her manufactures, but her efforts have always been to open up new markets, until she has forced her way to the remotest regions of the earth. It is said that the sun never sets on the British flag; it certainly never sets on British manufactures.

In carrying out such a policy for the United States it is evident that the Spanish American countries offer themselves to us as our natural field for enterprise. As already pointed out, our labors in this field would be of mutual advantage to them and to us, and in more ways than one: while receiving from us our labor-saving machinery and wonderful mechanical appliances of all kinds, they would also imbibe a portion of the spirit which led to their invention and use. We, on our part, would not only receive from them the rich products of their fertile soil, but might also catch, by contact with men of another race, something of that natural grace and refinement in which our national character is said to be deficient.

It may be reasonably expected that the recent completion of the new Havana water-works by American contractors will form another

link in the commercial relations between Cuba and the United States. These works have been already described and illustrated in this Magazine in the article by Mr. Chibas, already referred to, but a few details may not be out of place here. The contractors were Messrs. Runkle, Smith & Co., of New York, the present writer being their consulting and executive engineer from the commencement to the end of the work. It was begun in 1890, and the water was turned on in January, 1893. The final estimate considerably overran $2,000,000. The history of these works is somewhat curious. They were originally projected by an eminent Cuban engineer, the late General Albear, some thirty years ago, and a good deal of work was then done, including the collecting-basin for the springs, and the tunnel under the river Almendares,—both fine pieces of engineering. Many causes, however,—among them ten years of revolution,—combined to interrupt the work, and the failing health and lamented death of the distinguished author of the project deprived it of its leading spirit. The eminently successful completion of this work under American auspices undoubtedly marks a favorable era in the relations between the two countries, and I believe it may be truly said that it has increased the respect and esteem for the American name among the best elements of Havana business and official circles.

SAVING A WRECKED VESSEL.

By Gustav Kobbé.

IN ancient times, so far as we know, when a vessel went to the bottom, she stayed there. We have made advances since then, though not to so great an extent as might have been expected. If a vessel sinks inside a harbor or sound where there is comparatively smooth water we can raise her. But if one goes down at sea—outside of Sandy Hook, for example—we are still as helpless as the ancients. The "tools" for "outside work," as the wreckers say, do not exist. The surge would simply rip pontoons and chains to pieces. It is the unceasing motion of the sea, and not the depth, that makes it impossible to raise a vessel that has gone to the bottom of the ocean. Depth, to the limit at which a diver can work with certainty, say forty fathoms, is not a factor in smooth water. Inside work is successfully done on a large scale. But the ship which the open sea has drawn down into its depths can never be reclaimed. Otherwise, the greenish light which penetrates the surge off the Long Island coast would not disclose the helpless form of the *Oregon*, and other vessels which still lie where they went down would again be breasting the waves.

The man who has devised some apparatus for "outside" work is a familiar visitor in the offices of wrecking companies, who are asked to pass upon perhaps a dozen appliances of this kind every year. Some require novel fittings aboard ship to which the apparatus can be attached when anchored over the sunken craft, so that every vessel would be built with the idea that one day she was to sink,—a proposition to which probably neither builder, owner, nor skipper would care to subscribe.

While the raising of a sunken ship requires operations on a somewhat larger scale than getting a stranded vessel off a beach or reef, the latter calls for a vast amount of ingenuity. The number of difficulties to be overcome and sudden emergencies to be met would surprise one not conversant with the subject. Moreover, a stranded vessel must usually be got off in a storm but little less severe than that through which it came to grief, so that a wrecker must have the courage to face possible death by the very elements which wrecked the ship. The wrecker who, when the waves begin to pound threateningly against the stranded vessel, jumps over the lee rail and runs ashore, is as cowardly as the soldier who throws down his musket and

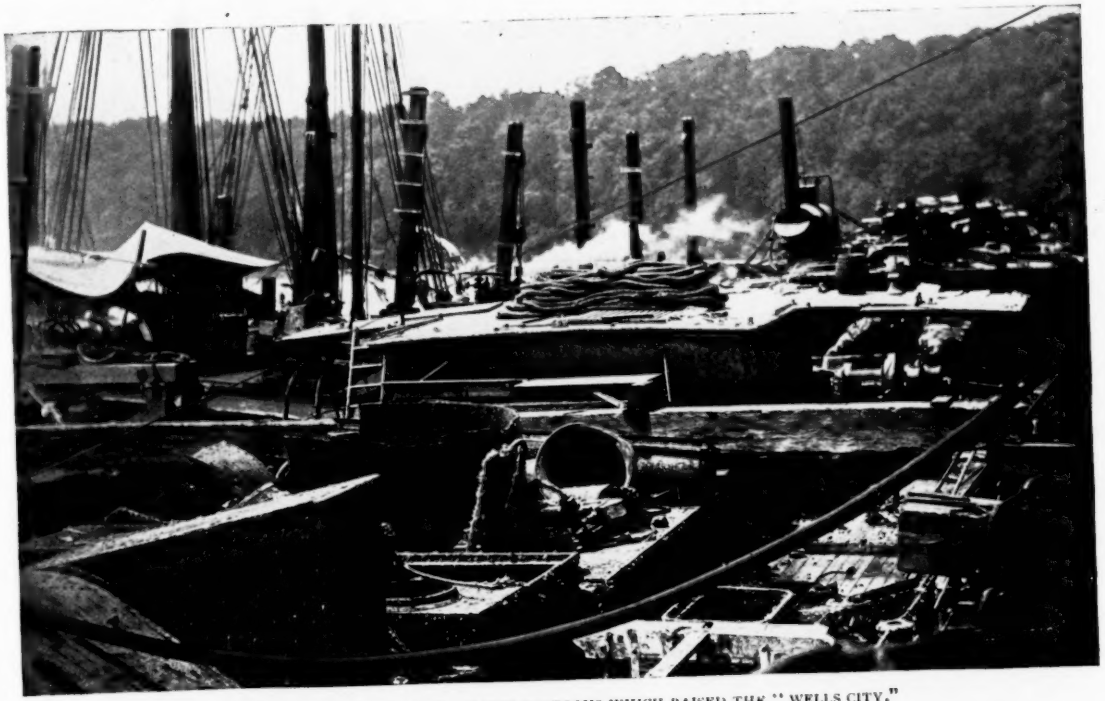
PONTOONS IN PLACE FOR RAISING THE "WELLS CITY," IN NORTH RIVER.

makes a dash for the rear. It is indeed an interesting feature of these operations that the sea—the power that throws a vessel helpless upon the beach—is by the wreckers coaxed or worried into aiding them in getting her off. Certainly there is poetic justice in this.

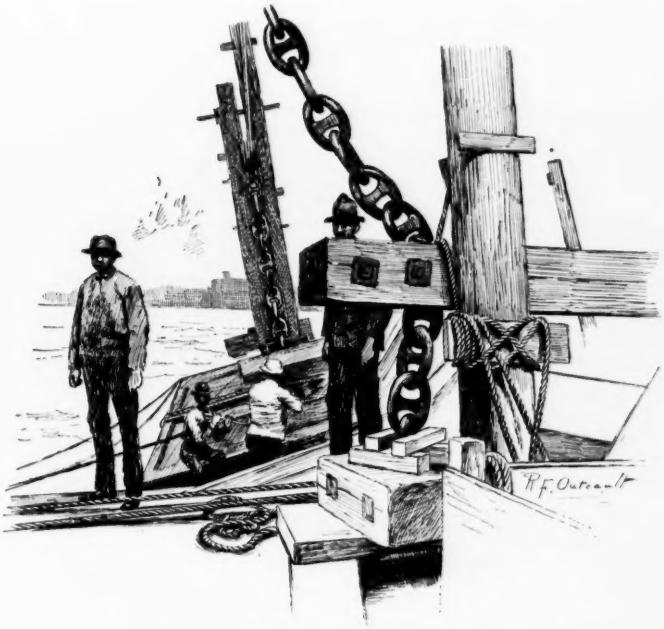
When a vessel goes on "light" she is of course cast up much farther on the beach than if she had been heavily laden, and the difficulty of getting her off is correspondingly greater. Launching a ship off the ways and getting her off a beach are two very different operations. The latter is like resuscitating the drowned. You may work and work and work—and, in the end, fail. But you have made a noble effort to bring, in the one case a human being, in the other a ship (which to me is almost human), back to life. There is an instance of wreckers having worked eighteen months over a stranded vessel. But they had the satisfaction of seeing her once more unfurl her white pinions to the breeze and, arching her bow over each oncoming wave, glide, like her old self, a thing of exquisite beauty, through the sea.

One of the wrecking companies in New York has as its trade-mark the picture of a stranded steamer, showing also the wrecking cables at her quarters. This is the *Pottsville*, the salvage of which is considered one of the finest pieces of work in its line ever done. This vessel went ashore in a southeast gale about ten miles north of Barnegat. She was light and was therefore driven high up on the beach. The procedure in cases like this sounds very simple, but details requiring instant decision are constantly coming up, where a wrong decision might be fatal to the enterprise. Briefly, you attach cables, with anchors seaward to the vessel, and, as the sea strikes her, she "goes to the cables." After you have lightened her of cargo or ballast, you stay on her and meet the elements: that is, fight what put her there.

Four cables, all told, are utilized in working off a stranded vessel. They are of manila, are from fifteen to twenty inches thick and 200 fathoms long, and have anchors with immense flukes weighing from 6500 to 7000 pounds. Two of these great cables are attached to the vessel itself, one to each of her quarters. It is calculated that, when there is a strain on these 200 fathoms of cable, an elasticity of from six to ten fathoms is developed, and it is this elasticity which causes the vessel to go to the cables when she is struck by a sea. The cables are protected aboard the vessel by great chocks which are themselves lashed with rope and thus increase the amount of spring. The other two cables, called "backers," are designed to increase the hold of the first two, and are attached to these about two-thirds their length out. These "backers" often come into play when the vessel has been got off the beach, but has still to surmount the bar. If the first cables



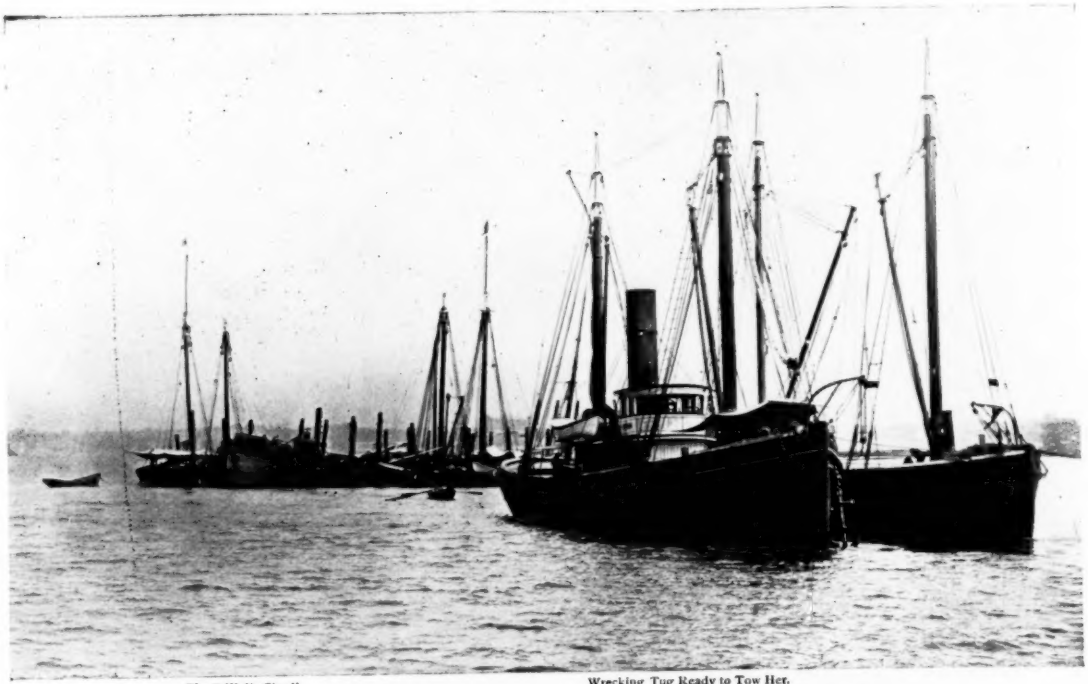
NEAR VIEW OF THE DECKS OF THE PONTOONS WHICH RAISED THE "WELLS CITY."



PONTOON CABLES USED IN RAISING A WRECK.

only carry her to the bar they are slipped and she is worried over the outer shoal by the "backers."

It required about five months to get off the *Pottsville*. She had been carried so far up on the beach that a storm severe enough to strike her and make her go to the cables would be severe enough to break her up. It was therefore impossible to save her as she lay. Means had to be devised to meet this difficulty at the outset. It may seem that the least likely method of rescuing a stranded vessel would be to ground her still more firmly. Yet that was what was done in the case of the *Pottsville*, and it was that which saved the vessel. They built a coffer-dam around her to a depth of 4½ feet below the line on which her keel lay, and running three feet wide around her. She was undermined in such a way that her keel remained resting on ridges or blocks of sand. Water was then pumped into the cavity. When it was full the ridges or blocks of sand which supported her keel were washed from under her with jets and she settled herself as lightly as an egg-shell 4½ feet further down into the sand. But sand, when the beach is



The "Wells City." Wrecking Tug Ready to Tow Her.

THE "WELLS CITY" AFTER BEING RAISED.

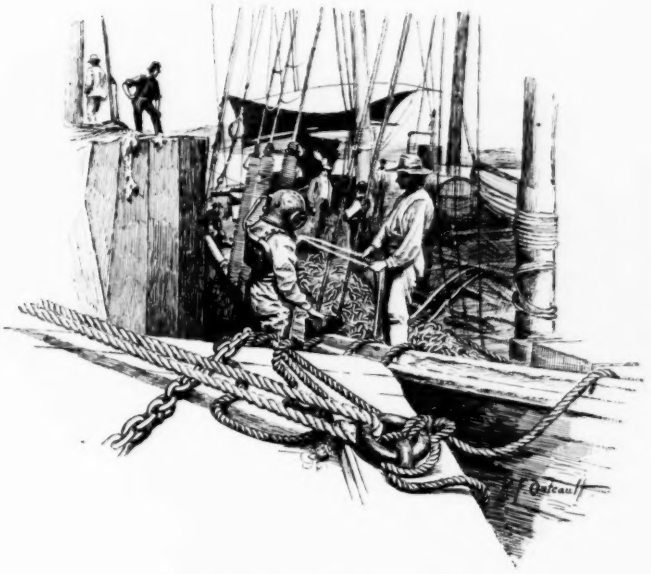
all awash during a storm, is little more than slush, and by means of this coffer-dam they had, as she sank 4½ feet deeper into the sand, brought her that much nearer her "bearings" or line of light draught; the effect, when the waves washed and struck her, being the same as if the wreckers had hauled her down the slope of the beach considerably nearer the surf-line. It took two months to build that coffer-dam, the planks being laid with hydraulic pressure and the nicest judgment being required to undermine her and yet leave sufficient support to prevent any shock or strain—but the coffer-dam saved her.

When the sea strikes a stranded vessel and she goes to the cables the wreckers haul in on the purchase and hold her; but it requires experience to know just the right moment to heave or slack, for the strain on the cables may become so great that they would snap like clothes-lines if they were not eased off at the command of an experienced superintendent. Sometimes the vessel will pound so hard that your teeth will rattle. Those are the times in wrecking when you need "sand" as well as experience. Here is wave after wave sheeting over the beach and breaking against the stranded ship, and instead of retreating before this angry sea you are deliberately getting nearer to it; struggling, not to escape from the jaws of death, but apparently doing your level best to get into them. And it is heave, heave, heave—toward the very fate which perhaps overtook the vessel's original crew.

As a matter of fact, wreckers have lost their lives in attempting to rescue stranded vessels. In the case of the *Circassian*, a full-rigged iron ship 280 feet long, which went ashore at Bridgehampton, Long Island, twenty-eight souls perished. This vessel had previously been stranded on Sable Island, and on Squan beach, New Jersey, a persistency in the wrong direction which would have had its humorous aspects had it not ended in a dire catastrophe. Among the wrecking crew who attempted to get her off the Bridgehampton bar were a number of Shinnecock Indians, and, for fear these might desert at the critical moment, the wrecking superintendent refused to comply with the suggestion of the keeper of the life-saving station that he run a cable ashore from the ship. The wreckers were warned that a storm of unusual severity was impending, but they knew that an unusually severe storm would be required to cause the large vessel to go to the cables. Instead of doing this, however, she broke in two in the furious seas that raged over her. No boat could be launched in such a surf to go to the aid of those who clung to the rigging, and no shot-line could reach them in the teeth of such a gale. The mizzenmast went by the board with thirty-two men clinging to it and of these only four reached shore.

No wrecking operations on stranded vessels have exceeded in ingenuity the rescue of the *Pottsville*. Of like importance in another

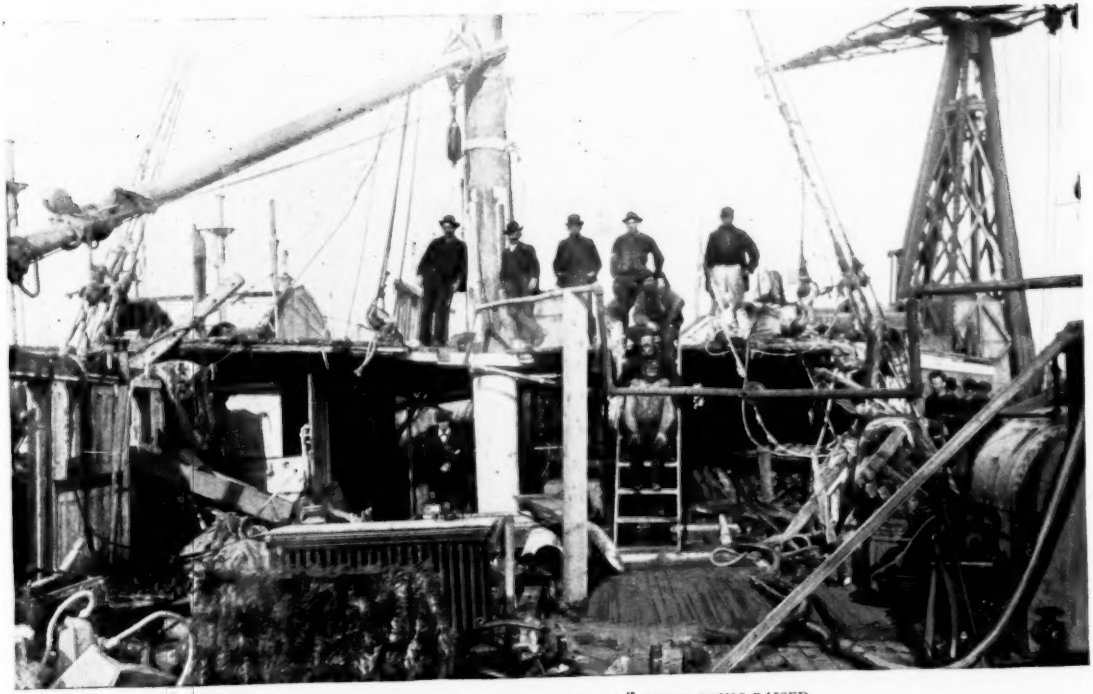
DIVERS READY TO DESCEND TO A SUNKEN SHIP.



A DIVER AND HIS APPARATUS.

line of wrecking, the raising of a sunken vessel, was the work on the *Wells City*, an English steamer of some 2000 tons which sank with a cargo of tin in February, 1887, off Christopher street, New York, and was for months an object of interest to the multitude of travelers by the Hoboken ferry. She had been anchored in the river some distance above the spot where she went down. One night the ice-floe caused her to drag her anchor and she was borne helplessly down upon the American steamer *Guyandotte*, which knocked a hole in her and sunk her. Nothing could be seen of her except part of her smokestack and masts. The ease or difficulty of raising sunken vessels is largely a matter of location; and the *Wells City* could hardly have been in a much worse place. She lay broadside to a strong tide so that the divers who worked in and about her were limited to the hour or two of slack water. Then, too, owing to sewage and refuse from shipping, the water is very dirty there, so that the divers were obliged to practically work in the dark.

The first evidence that an attempt was to be made to raise the vessel was the appearance of a powerful tug with a number of schooners with sailless masts but with decks covered with pumps, engines, coils of



DECK OF THE U. S. S. "TALLAPOOSA" AFTER BEING RAISED.

cable, and chains and diving apparatus. The schooners were anchored on either side of the wreck, while the tug lay to nearby. The first step in the operations was for the divers to take out the cargo of tin blocks. This, owing to the darkness of the water, required that the grips be adjusted to the blocks by the sense of touch, the divers remaining ever on the alert for the signal that would recall them before the tide began to rush in or out with such force that there was danger of the life-line or hose snapping—which latter means death. One night a canal-boat crashed into the smokestack and one of the masts, carried them away, and sunk over the *Wells City's* stern. The clearing away of the wrecked canal-boat and diving for the smokestack caused several weeks' delay and there were other vexing outside accidents due to the awkward location of the wreck.

The cargo having been removed, the six pontoons through which the raising power was to be finally applied were towed into place and distributed in pairs, three on a side, on either side of the wreck. The idea was to pass chains under the vessel's keel and up through the pontoons fastening the chain-ends to the pontoons: sink these by pumping in water to about a level with the river; then pump them out so that their buoyancy, applied at the chains, would raise the vessel a certain number of feet. She would then be towed into shallower water until she grounded and the operation would be repeated until enough of her was out of water to enable the wreckers to "plug her up" and pump her out when, of course, her own buoyancy would float her.

Three sizes of pontoons are used by the company which raised the *Wells City*. The largest, which have a raising capacity of 800 tons to the pair, are 96 × 16 feet and 11 feet deep. The two smaller sizes have a raising capacity per pair of 500 and 400 tons. The wells through which the chains pass are ⩘ shaped, so that the chain can run at an angle from the bottom of the pontoon without serious chafing. The three pairs of pontoons used on the *Wells City* had a greater raising-capacity than the ship's tonnage. But the fact that there were about eight feet of water over her deck and that a great amount of sediment had, as in all such cases, gathered in her frame and even under her ceiling, made this apparent excess of power necessary. Immense chains of three-inch thickness were used on these pontoons, but of course such thick chains cannot be passed under a vessel's keel without preliminaries. A sweep chain or "messenger" must first be worked in under. This is a small chain which literally saws in through the mud and stone at the bottom of the river to the point under the keel where the main chain is to be passed from pontoon to pontoon. Several chains of increasing thickness are then sent under, each acting as messenger for the next, until the three-inch chain is drawn through under

the vessel to the pontoon on the opposite side. Chain after chain is thus adjusted until a sufficient number are in place. Sometimes the progress of the "messenger" is checked by a conglomeration of stone at the bottom. Then pumps are lowered and the obstruction pumped up. The company which raised the *Wells City* has in its cabinet of curiosities a stone nearly a foot long and proportionately thick. This stone was pumped up with a mass of other stuff, including a heavy lock which did not belong to the vessel at which the wreckers were at work.

The chains which are drawn by "messengers" under the vessel's keel pass up through the pontoon-wells to the pontoon-decks where there are toggles for fastening and adjusting them. The chains are examined link by link before they go into the water and there is an immense amount of heavy hammering and other smithy work done on the decks of the wrecking-schooners. When the chains are all in place the pontoons are pumped full. As they sink the slack of the chains is hauled in and made fast, so that the moment the pumping-out begins the lifting-power of the pontoons is applied, and, as they rise, they raise the vessel whose keel rests upon the chains in proportion as their buoyancy exceeds her weight.

The first attempt to raise the *Wells City* failed. For, as the vessel was lifted off the bottom, her keel cut through one of the chains as smoothly and cleanly as a knife cuts through an apple, and click, click, went the others, unable to bear the extra weight put upon them. This is one of the exigencies of wrecking. At the first attempt to raise the *Atlas*, which was sunk by a ferry-boat in the North river, a sudden surge grated one of the chains between the keel and some rocks on the bed of the river, and the keel cut through the chain like a cold chisel, the other chains bursting with the sudden excess of strain put upon them. It is, of course, an important point in the operations to equalize the strain on the chains. This is accomplished by thirty-ton hydraulic jacks and levers on the pontoon decks. The pontoons are connected by heavy timbers, and at the right moment a man rapidly makes the circuit of them and tests the strain. Experience enables him to tell at a touch if all is right. Thus a strain of tons is as delicately adjusted to the touch as is the key of a piano.

When the chains under the *Wells City* broke, the whole tedious operation, which can be told in so short a time but which occupies weeks or even months in the carrying-out, had to be repeated. At the next attempt, however, all went well and she was raised five feet. Then the wrecking-tug towed the six pontoons with the wreck, still submerged, suspended between them into shallower water. Raised again she was again towed nearer shore, and this was repeated until she could be coffer-dammed, plugged, and pumped out.

Some years ago the steamboat *Thomas Cornell* ran on a reef in the Hudson river near shore, with such force that her bow ran far up on the high bank, knocking away trees and scattering débris. It looked as if she were planted there forever, for she lay at a great angle, her stern nearly submerged, her bow high up on shore. To get her off was a delicate piece of work. The pontoons could be placed only along that portion of her which was in the water, yet to prevent her snapping she had to be lifted off at the exact angle at which she lay—and this was accomplished.

On the lakes, where there are few natural harbors and often deep water to the bank, so that there is no opportunity to ground a partially-raised vessel, they bring her right up where she sank. For this they use several sets of pontoons. Suppose, for instance, that four pontoons are on the spot. They partially raise her and hold her with one pair, and then go down and raise her further and hold her with the other, repeating this proceeding until they have her up.

For large vessels, like the *Wells City* and the *Atlas*, pontoons are the only practical lifting-power that can be successfully applied. Smaller craft can, however, be hoisted by derricks and in such instances these are often employed. A powerful derrick is now building for one of the wrecking companies and with this it is expected to accomplish greater results than have hitherto been attained by such means. Vessels which have simply stuck their noses into the mud or sand can readily be hauled off by tug-boats.

In accounts of foreign wrecking operations we often read of large vessels being raised. But these accounts are misleading. The tidal rise and fall are so great where the scene of these operations is laid that at low tide the vessel is comparatively high and dry and can be plugged up and pumped out—much the same as if she had been dry-docked.

In the cabinet of curiosities which I mentioned above I saw a sword which had gone to the bottom in three different vessels of the United States navy—in the *Cairo*, off Yazoo in 1862; in the *Conestoga*, in the Mississippi, in 1863; and in that terror of the seas, the *Tallapoosa*, in 1884.

TOWN-REFUSE DISPOSAL AND ELECTRIC-LIGHTING.

By Thomas Tomlinson, Assoc. M. Inst. C. E.

WHATEVER a town council may do or leave undone, it must make arrangements for sanitation and public lighting. When the town council, already burdened with the necessity and saddled with the cost of the collection and disposal of the town refuse, becomes also the provider of light for public and private purposes, it would seem that any suggestion as to the economy resulting from the combination of refuse destruction with electric-light production should be acceptable. The possibility of such a combination lies in the disposal of the refuse by fire in destructors and the utilization of the waste heat for steam-production, the steam being used in driving the engines employed in the electric-lighting.

Whether economy shall ultimately result from such a combination, or not, depends upon (1) the coal value of the heat so utilized; (2) the total coal required for the production of the light (and power) required; (3) the loss in distribution involved in the displacement of the electric station from the best available site (from an electrical point of view) to the destructor station, or interest on the extra cost, in distribution works, to keep the loss the same, or more generally some combination of the two: (4) the difference in value of the sites and necessary buildings; and (5) the coal value of the saving effected by condensation where the destructors are situated at the sewage outfall. In fact, whether a saving will be effected can be definitely stated in any particular case only when we have determined the total cost of a unit delivered at the consumer's terminals from the best available site from an electrical point of view and from the existing—or, if not existing, then the best available—site for a destructor station.

The necessity for such detailed examination would not exist if it could be shown in general that the coal value of the waste heat of the destructors was either very large or very small compared to the total coal required for electric-light production in any district. In the former case we should be forced to take the optimistic view that the combination of destructor station and electric station is always sound; in the latter case we would be driven to the pessimistic conclusion that the combination is never sound, never advisable, unless of course under the extremely unlikely condition of the best available site, from an

electrical point of view, coinciding with the destructor-station site—unlikely, because the best electrical site is that which is nearest the center of density of the lighting, while the destructor site is most likely to be on the outskirts of the district.

It becomes of importance, therefore,—and, fortunately, it is not impossible,—to arrive at some approximate general conclusions.

It will be advisable, at first, to confine our attention to the destruction of ash-bin refuse,—that is, of the house refuse collected from a district,—leaving out of sight for the present the possibility of dealing with excreta, water-carried or periodically removed from ash-pits, middens, or pans.

Ample statistics are available, both as to the quantity of ash-bin refuse collected yearly from towns of very different sizes and classes, and as to the value in steam-raising power of the waste heat; unfortunately, in both particulars, quantity and calorific value, the figures show a very wide range,—so wide in fact that, by selection of a suitable figure for quantities coupled with a suitable figure for calorific value, any proposition as to the value of the waste heat of destructors in connection with electric-lighting could be proved.

I have elsewhere* given, at too great length to repeat here, reasons for believing that, with a water-carriage system of sewage, the ash-bin refuse may, for general purposes, be taken at 4 cwt. per head of population per annum, and further, that the evaporative value of the waste heat of such refuse, burned in a destructor under sanitary conditions, is from 500 to 800 pounds of water evaporated per ton of refuse burned. For a population of 20,000, then, on these figures, the coal-value of the waste heat of the destructors would be 112 to 180 tons (assuming an average evaporation in a central station of eight pounds of water per pound of coal).

Now consider the probable demands of a population of 20,000 for light. On the usual assumption of one 8-candle-power lamp per head for 500 hours per annum, we would have to deliver 300,000 units at the consumer's terminals, requiring 10, 12, or 20 pounds of coal per unit, according as the system adopted were low-tension direct current, high-tension direct or alternating with substations, or high-tension alternating without substations; that is, we should consume 1340, 1600, or 2680 tons of coal per annum, according to the system adopted. The last system is practically obsolete, and the first rarely admissible over a wide area, so that, in general, we may take it that the question for decision is whether it is worth while to place the electric-light sta-

*See *Electrical Review* (London), Vol. XXXIII, Nos. 819, 820, etc. Also, "Refuse Destructors and their Results up to the Present Time," by Charles Jones, with a chapter on "The power available from Destructors," by Thomas Tomlinson. Second edition. London: Biggs & Co.

tion on a site not the best for distribution, but with a bonus of 7 to 11 per cent. of the total coal required and possibly with the added economy of condensation (which would raise the percentage from 7 to 11 to 9 to 15), and taking into account the other factors in the cost of a unit delivered.

It should be noted that any increase in the efficiency of destructors and any increase in the amount of light obtainable from the combustion of a given quantity of coal (both of which are to be looked for in the near future) increases the value of the waste heat of destructors, by increasing the coal value of their waste heat as compared to the total coal consumption; on the contrary, any prospective demand for light above that here assumed will tend to diminish their value for the contrary reason.

So much for the immediate prospects of utilization of ash-bin refuse only. We pass now to the question of excrementitious refuse and the possibilities of its utilization; remembering always that the first point to be considered is the sanitary result of our operations, and after that the financial result—the possible return towards recouping the cost of collection and disposal. The excrementitious matter may be disposed of in four ways:

I. Water-carried and discharged into the nearest body of water, without precipitation or clarification.

II. Water-carried, the solids precipitated as "sludge" and the clear effluent alone discharged into the nearest body of water.

III. Periodically—at long intervals—removed from cesspits or middens into which ashes, cinders, and general household refuse are also deposited.

IV. Periodically—at short intervals—removed in pails.

In the first case the stuff is effectively dealt with—for the time being. Whether we have or have not transferred to a future generation, or our own grown older, a Herculean task of Augean-stable cleansing, depends upon the size of the waterway into which we discharge the refuse and the present and future size of our city.

In the second case we shall have to dispose of the sludge from the settling tanks—air-dried or pressed. As swept from the tanks the stuff consists of nine parts by weight of water and one part by weight of solids; after pressing it contains one part by weight of water and one part by weight of solids. Of this pressed sludge the amount obtained is from $1\frac{1}{2}$ to 2 cwts. per head population per annum. At first it was supposed to have high value as a manure, but now it is pretty generally recognized that it has practically no such value, and that it must be dealt with on the spot.

The first systematic attempt—in England, at any rate—to deal on

the spot with both the ash-bin refuse and the sludge, and, so far as I know, up to now the most complete and most practical plan, is that adopted by Mr. C. Jones, M. Inst. C. E., at Ealing, near London. The plan adopted is interesting to us because it essentially consists in mixing the ash-bin refuse and the sludge—drained and-air dried however, and not pressed—in the proportions in which they occur (two of sludge to one of ash-bin refuse by weight) and burning them together in exactly the same type of destructor as is elsewhere used for ash-bin refuse alone; and further, because the calorific value of the waste heat per ton of the mixed stuff is represented by an evaporation of 700 pounds of water per ton of refuse burned, as against 500 to 800 pounds evaporated per ton of ash-bin refuse alone.

Now, as there are 4 cwts. of ash-bin refuse per head of population per annum and 1⅓ to 2 cwts. of pressed sludge per head per annum (and the higher figure will probably be the nearer the correct one for drained and air-dried sludge), we have an actual increase in total annual evaporation, or total annual power available, of from 16 to 30 per cent. by burning the two together, even if we adopt the highest figure of 800 pounds per ton burnt for ash-bin refuse alone.

By burning the ash-bin refuse and sludge together we therefore increase substantially our total output, and so increase the value of our destructor waste heat in connection with electric-lighting, and at the same time get rid of the sludge, which becomes a serious nuisance the moment its absence of manurial value is discovered in any district, and its disposal as manure by gift or sale becomes impossible.

This Ealing result will repay examination in another direction. Every ton of the mixed stuff contains ⅔ of a ton of ash-bin refuse and ⅓ of a ton of sludge; the evaporation due to the ⅔ ton of ash-bin refuse is $2 \times \frac{800}{3} = 533$ pounds of water; the total evaporation is 700 pounds of water; therefore the total actual evaporation due to the ⅓ ton of sludge is 167 pounds of water, so that the evaporation due to one ton of sludge is 500 pounds of water. Now, remembering that the sludge itself contains at least 50 per cent. of water, or 1120 pounds per ton, which must be evaporated before it can do any evaporative work outside the destructor, it is pretty evident that the solids and gases of the sludge must be of pretty high calorific value.

A very simple investigation will establish the main source of this to be the gases contained in the sludge. To establish this it is only necessary to distill a small quantity of freshly-pressed sludge-cake and to collect, and afterwards burn, the gas given off; this will be found to amount to about 3800 cubic feet per ton of pressed sludge. We may fairly enough take average results from a number of small samples as indicating the general results to be obtained on a large scale, owing to

the homogeneity of the material; besides, there is at least one corroborative result on a fairly large scale—an experiment by Mr. Lomax of Nelson, Lancashire, which gave 3300 cubic feet of gas per ton.

The fact that sludge can be burned in an ordinary destructor, in combination with ash-bin refuse, is in itself of considerable importance, as it makes it possible to get rid of a very considerable quantity of material which, considering its composition, it certainly is not desirable to tip upon ground ever likely to be built upon, and for which, in the absence of manurial value, there appear to be only two alternatives—tipping or burning. The fact becomes more important when it is seen that the burning involves no loss, but on the contrary, a gain of steam-raising power in the waste heat of the destructor. There seems to be little doubt that, in any district where a system of house-to-house collection of ash-bin refuse is adopted, and where also the solid matters of water-borne sewage are precipitated before the discharge of the effluent, sanitary requirements will be best fulfilled by burning the two classes of refuse together, and that, under favorable circumstances which admit of the utilization of the total waste heat, the cost of disposal of the refuse may be considerably reduced,—probably below the cost of disposal in a less sanitary manner.

As indicating the possibilities of return towards reducing the cost of disposal, the statement of the result attained at Ealing is of value. The cost of destruction of the mixed stuff is stated to be 1*s* 6½*d* per ton (including interest on the cost of works) and the return in power and in the value of the clinker, for road-bottoming and path-making, is stated to amount to 1*s* 3*d*, leaving the net cost of disposal at 3½*d* per ton. This result is obtained with the old "Fryer," or low-combustion, type of destructor, having a fume cremator in the main flue; but at Leyton, another district of London, a plant is being erected to deal with the mixed stuff (the sludge being pressed, however) in one of the modern high-combustion destructors with forced draught, moving firebars and all the latest improvements.

It will be interesting, bye and bye, to compare the results of the two processes; but, with full knowledge of the danger of prophesying before the event, I shall look to the older combination to give the best results in value of the waste heat, and for these reasons: In the old style "Fryer" destructor the refuse is fed in from the back of the destructor and the flue leading to the main flue is always at the back of the destructor; therefore all gases given off at a low temperature will pass off, from fresh charges, unconsumed into the main flue. Indeed it was this, coupled with the fact that these gases stink abominably, which first brought destructors into disrepute and then led to the devising of the remedies—the addition of the fume cremator to the old

type of destructor on the one hand, and the introduction of the modern or high combustion type of destructor on the other. The fume cremator is simply a furnace with reverberatory arch placed on the line of main flue. The gases pass through the furnace over a fire of cheap fuel to which they are deflected by fire-brick deflecting curtains turned in the reverberatory arch and are then raised to the temperature required for their combustion. Where the waste heat is utilized for raising steam the crematory is placed as near to the boilers as possible.

In the case of the high-combustion destructor, forced draught is used (usually a steam-jet) so as to raise the temperature of the furnace as high as possible and the flue leading to the main flue leads from the front of the furnace: as the refuse is fed in from behind, the gases which are given off from the fresh charge must, before reaching the main flue, pass between the reverberatory arch of the furnace and the intensely hot fire below and there be consumed. In both cases the gases given off at a low temperature are consumed by being subsequently passed over a red or white hot fire.

It will have been found, in making the experiment in the distillation of sludge-gas, that the gas is given off at a low temperature and with extreme rapidity. Where sludge is burned in the low-combustion destructor the gases are consumed in the cremator, and where it is burned in the high-combustion destructor the gases are consumed in the furnace. Now in practice, when the waste heat of destructors is utilized for steam-raising, the boilers are necessarily placed at some distance from the destructors, the distance amounting to 100 feet or more in a big scheme. The great loss of heat due to the passage of hot gases through long lengths of flues is well known, especially in connection with fuel-economizers, which are always placed as close to the boilers as possible on this account, and it is reasonable to expect that in practice the return in power will be greater when the gases are burned close to the boilers in a cremator than when they are burned in the destructors at a distance.

An obvious further deduction may be made which may be of importance in future developments, namely, that a still better return would be obtained if the gases were ignited actually *in* the boiler-furnace. To do this it is only necessary that we should use the waste heat of the ash-bin refuse to distill the gases from the sludge, and, as the sludge is well suited for mechanical manipulation and gives off its gases readily, there is no practical difficulty in arranging for the necessary conditions for success of the sludge passing in a retort in a thin layer over a surface heated by the waste heat from the ash-bin refuse, nor is there much difficulty, if it were found advisable to do it, in passing steam or steam and air over such an incandescent layer and con-

verting the carbon also into gas, to be subsequently burned actually in the boiler-furnaces.

In addition to the increased return to be thus attained, in all probability, there are two further points worthy of note. The power, in this form, would be capable of transportation and storage, easy, cheap, and with small loss; the first—capability of transportation—would increase the value of the waste heat from destructors, in connection with electric-lighting, by freeing us from the necessity of placing the electric-light station in a position probably unsuitable and entailing loss in distribution; the second—capability of storage—would still further increase the value of the waste, because it would render it available just when we wanted it and at a moment's notice.

The increase of value which would result from the location of the electric-light station not being confined to a possibly unsuitable site, may be inferred from the reasons already given as to the loss arising from its being so tied down: the increase of value which would result from its being available at short notice, depends upon the fact that a considerable proportion of the fuel burned in an electric-light station is consumed merely in being ready for the coming on of the heavy load and in the large fires left on as the heavy load comes off; this loss has been stated by Professor Kennedy, F. R. S., from observations on a large London electric-light system, at 10 per cent. of the total fuel consumed.

It seems then quite possible that, treated in the manner above indicated, the value of the return from ash-bin refuse and sludge of a given population may be increased from the 7 to 11 per cent. (as already deduced) to 15 to 20 per cent. of the total fuel consumed for the electric-lighting for the same population. If this result were obtained the cost of disposal of the refuse would be certainly covered, and perhaps also some part of the cost of collection and precipitation. The balance would have to be charged to the account of the public health, just as the whole is under a system of disposal to shoot. More than this cannot be expected—the city dust-yards and the sewage-works are no municipal El Dorados.

We pass now to the third manner of disposal of the excrementitious matter—periodical collection, at long intervals, from middens or cesspits. I am not aware of any town in which the collected stuff is disposed of otherwise than by carting it upon land as manure, which necessitates piling it up in huge heaps in the town-yard until the season for its application to the land comes round.

This brutal practice is, I believe, wholly unnecessary from an economical point of view—that is to say, the treatment of the midden refuse of any fairly affluent community burning coal may be made to pay for itself, or nearly so, by the return in power.

In an experiment recently conducted by me * on some ten tons of newly-collected midden stuff taken at random, I found that it was perfectly feasible to treat this stuff without offence and to have over a surplus of power (in the form of cinder and fine coal) which would pay for the cost of the treatment.

The process consisted essentially in driving off the moisture and gases from the stuff by heat in a closed retort, the steam and gas being drawn from the retort by a steam-jet ejector and forced through the furnace fire. The destruction of the offensive gases was so complete that the experiment was conducted with a 14-foot chimney within sixteen yards of a high-road without offence. The fuel for the furnaces of both the retort and boiler was supplied by part of the cinders and fine coal riddled from the treated stuff.

The result of the last experiment showed the following balance-sheet, the amount of refuse treated being 6 T. 17 cwt. 1 qr. = 549 qrs.:

	Quarters.	Per cent.		Quarters.	Per cent.
Fuel used	172	31	Pots, crockery, etc.	16	3
Fuel over-cinders	40	25	Clinker	36	6
breeze	92		Ashes	22	9
Dust (carbonaceous)	141	26	Water (by difference)	31	

This experiment was made with an ordinary cast-iron retort which was very badly set and very inefficient. The retort was hand-fed but there is little difficulty in arranging for mechanical feeding, and the experimental result is so promising—a return of 25 per cent. of the total weight treated, as fuel over and above that required for the treatment and that with a single inefficient retort—that the engineer of a town with a midden system might do worse than consider the matter.

In this case also the return from the destructors is in such a form as admits of easy and cheap transportation and storage with these attendant advantages from our point of view; but it has not the advantage of being available at short notice as in the last case. In the fourth manner of disposal of the excrementitious matter—the pail system—no possible return in the form of power is available.

* See *Electrical Review* (London), Vol. XXXIII, Nos. 824, 825.

THE PHENOMENA OF ALTERNATING MAGNETIC FIELDS.

By Elihu Thomson.

THE great advances made during the past seven or eight years, in the employment of alternating currents of electricity to supplement or even to supplant the continuous current in the transmission of power and in lighting, are well known. We are learning from day to day more and more of the wonderful capabilities of such currents as well as of their great flexibility. The facility with which we may transform electric pressures and currents in alternating-current work, so as to exchange a few amperes at thousands of volts pressure for thousands of amperes at a few volts pressure, or the reverse, is one of the great advantages possessed. The transformation, made as it is by a simple induction coil of wire and iron without moving parts, is also accomplished with such high efficiencies as 97 or 98 per cent. We may have alternating-current waves of any pitch or frequency, of any quality or shape of wave, of any amplitude or power. We may have two or more waves of the same pitch, but not in the same phase, working together in the same system or produced therein by suitable devices from a single wave. Thus arise multiphase or polyphase currents, the best-known relations of phases being two-phase and three-phase currents. The capability of such currents to produce rotary magnetic fields, and, as a result thereof, rotary movement without commutators, is of great and increasing importance in technical work.

In addition to these developments of alternating-current work we may in the future be able to note special applications of waves of different pitch superposed, and with various phasal relations. We have already telephone systems which depend on the superposition of waves of every pitch on the same system, and we may possibly look forward to other applications on a larger scale of similar superposed waves. The possibilities for future research in the alternating-current field are still great, notwithstanding the very important advances made within the past few years, many of which are still but little known, some remaining still buried in the patent office, while others are yet confined to the laboratory.

The purpose of this paper is to present in simple form the general characteristics of an alternating-current magnetic field as distinguished from the field of a permanent magnet or one produced by a steady

electric current, and to point out the uses which can be made of the properties of the alternating field. The subject itself is so extensive that it will be impossible to be at all thorough in the consideration of phenomena so varied and oftentimes so complex. Experimentation is needed to convey a proper idea of the actions to which we shall allude, as well as to give a true understanding of their diversity. At the same time, the theory of the actions exhibited would require a graphical or mathematical analysis to render the account complete.

When an electric current is passed continuously in one direction through a single wire there is set up around the axis of the wire a magnetic field such that a piece of iron in proximity to the wire will have developed in it the peculiar magnetic state and will have north and south poles. If the current in the wire be in a direction away from the observer when the wire is viewed on end, the north pole will be directed in a path around the wire corresponding to the right-hand movement of the hands of a clock. If the current be reversed in direction, the magnetic relations or directions will be likewise reversed. In the same way, if the wire or conductor be coiled into a helix or spiral coil and a current be passed through it as before, a magnetic field will be produced around and through the coil such that a piece of iron wire inserted into the axis of the coil will become a magnet. If the magnet be viewed on end its north pole will be directed away from the observer when the current passes around in the same direction as the hands of a clock, and vice versa. This relation may be easily remembered in the phrases, "Right-handed direction of current, north pole directed away," "Right-handed direction of north polarity, current directed away." These statements, supplemented by their evident opposites for reversal of direction, "Left-handed direction of current, south pole directed away," and "Left-handed direction of north magnetism, current directed towards observer," are sufficient to give the key to very many magnetic and electric relations. It will be evident that if the current be intermittent the magnetic relations will be correspondingly so, and that an intermittent current will cause an intermittent magnetic field around a coil or conductor. If also the current be of the alternating character, reversing its direction many times per second, the magnetic field produced thereby will be of alternating polarity, or the direction of magnetic polarization will alternate. Such a field is an alternating magnetic field.

To intensify the effects of a magnetic field produced either by a steady, continuous current of electricity or by an alternating current, it is of course usual to employ an iron body or core, which, on account of its superior permeability to magnetic forces or susceptibility to magnetic excitation, gives much more intense actions than air. Just

what constitutes the difference between substances which, like iron, are highly magnetic and others but little different from air or vacuum in this respect, is as yet quite unknown. There are, however, very decided differences between the magnetic fields produced by steady, continuous currents, and alternating magnetic fields. The former may be called passive, or static in character, while the latter may in truth be referred to as active, or dynamic, as will appear more definitely when reference is made to the actions producible therein. The passive or steady field has no action on closed metal bands placed in it except during the act of placing, while the alternating field has a very decided action of one kind or another.

Let us assume, then, that we have side by side good examples of apparatus, one of which furnishes us with a steady magnetic field and the other with an alternating field. It will suffice for this to provide for the first an upright iron bar of say two inches in diameter and ten inches long as our magnetic mass, and surround it by a coil of insulated wire having a continuous current sent through it. We cannot properly select such an iron bar for our magnetic mass in the second or alternating field apparatus, because we should find not only that the effects obtainable from it would be comparatively weak, but the core itself would rapidly get hot, owing to currents induced in its mass. Instead, therefore, we build up a wire bundle to the desired diameter, say two inches, by taking a great number of well-annealed soft-iron wires of ten inches length and about one-twentieth inch diameter. These wires are either varnished before being collected together or well scaled in the annealing. They are thus insulated from each other, at least sufficiently for our purpose. We surround this bundle or iron-wire core by a coil which is traversed by powerful alternating currents, changing their direction say 100 or more times per second.

We have now the means for comparing the effects of a steady magnetic field at the end of the iron bar with those of an alternating field at the upper end of the wire bundle. Let us bring a piece of steel or iron of some size successively into each field. In the steady field it is simply attracted, and if of hard steel is found permanently magnetized on taking it away. It is not otherwise affected to any appreciable degree. But in the alternating field it is less strongly attracted and intermittently, as is evident from the tremor or vibration, and it soon becomes hot. If of hard steel, such for example as a file, it may become so hot in a minute or two as to be incapable of being held in the fingers. Energy or work is evidently being expended on the piece, and this is abstracted from the source which keeps up the alternating current in the coil around the wire bundle. Substitute for the steel a bundle of very fine iron wires or sheets of very soft iron, and

if these be presented on edge or in line with the field scarcely any heat is developed, but if the magnetic lines traverse the wires or sheets laterally the bundle at once heats.

We come now to consider a more decided difference between the two fields of magnetism—namely the action on closed bands or conductors, such as rings of copper, coils of wire with the ends joined, and plates, disks, etc., of metals which are good conductors for electric currents. We may take, for example, a ring of copper or a round disk of the same metal, say four or five inches in diameter, and place it flatwise against the pole of the steady field magnet and it is not perceptibly acted on in any way, while if the same be done with the alternating magnet there will be noted a powerful repelling force exerted on the ring or disk such that even though it be of considerable weight it will be lifted and thrust off the pole. The writer discovered this action in 1886 and experimented at length upon it in many modified ways. If the ring be held down to the alternating pole or near thereto it rapidly gets warm. Indeed, with sufficient energy of alternating field a ring five inches in diameter made of copper wire ¼ inch thick may be made red hot and kept so in mid-air indefinitely. With care a ring may be made to float in mid-air over the alternating-magnet pole for a second or two, but the condition is one of very unstable equilibrium. It is made stable by tying strings to the ring so carried downward that the ring strains them upward in being lifted off the pole.

The cause of the actions of heating and repulsion in the experiments just noted may be readily understood. Even when the ring was put over the steady pole, there was in fact a resistance to its motion but only during the act of placing or while it was in motion. If the ring be brought very suddenly over the steady magnet, it will be vigorously held off. Owing to this fact it is found to be quite difficult to strike the pole of a powerful magnet by a thin flat sheet of copper brought down by the hand, even when the magnetism is steady.

The reason is that during the movement in the field a powerful current is induced or set up in the moving sheet which reacts on the field and distorts it, with the effect of a repulsive effort exerted in the sheet to keep the sheet away.

Similarly, if the sheet has been laid on the magnet pole and an attempt be made to suddenly remove it flatwise there will be found a strong opposing force exerted to retain the sheet or disk. In this case the currents induced by the movement are in a direction to cause attraction to the magnet. When the alternating field is used the currents which are induced in the ring or disk are opposite in direction to those which would produce the magnetic field itself and a repulsive effort is therefore exerted. To put it differently, the lines of force of

the magnetic field in this case are opposed or distorted by the induced currents in the ring or disk. The reaction of these currents on the field producing them forces the ring or disk from the field Hence, the alternating field is capable itself of heating conductors placed therein and of exerting mechanical force.

It would be out of place here to discuss fully the theory of the actions induced. It may be stated, however, that the fact that the current waves induced in the ring or disk by the alternating field are retained or lagged in virtue of their self-induction, from their true relation to the inducing field, is the cause of the repulsion. The alternating magnetism of itself would produce no repulsion were it not that the currents lag in the ring or disk so as to become virtually opposing or repelling currents, instead of equally repelling and attracting to the field. Rings of brass or German silver are much less powerfully acted on than those of the best conductors, such as copper and silver. Hence, for example, a real silver dollar is repelled energetically in the alternating field while one of a base alloy is hardly affected at all. This is owing to the relatively smaller currents induced in the poorer conductor, as well as to the fact that the currents are not retarded or lagged sufficiently for the maximum effect. Let us substitute a coil of wire of many turns insulated from each other, for the ring in the repulsion experiment. In the steady magnetic field there is no effect, but in the alternating field there are waves of current induced such that an incandescent lamp connected to the terminals of the coil may be lighted when the coil is brought into the alternating field. Its brightness will vary with the position of the coil with relation to the lines of force and their density. The maximum effect will be when the whole of the alternating field is enclosed by the coil. As the coil is lifted away the brilliancy of the lamp serves as a rough measure of the reduction of the intensity of the field, or rather of its inductive action at a distance. Indeed, we may take advantage of the arrangement just referred to for securing a constant illumination of the lamp or a constant current in its circuit, by hanging the coil in the field to a scale-beam and so loading the same that the coil will have a definite tendency or weight tending to move it into a stronger portion of the field. This is counterbalanced by the repulsive action exerted on the coil so that the latter floats, as it were, in such a strength of field as will induce a definite current. Variations of the field, or the alternating current which produces such field, are compensated at once by an automatic adjustment of the coil in relation to the field.

This apparatus will undoubtedly be found useful in photometry for maintaining a standard current through a lamp. A very pretty modification of the experiment is that of the "floating lamp." A small

coil of wire has attached to it a suitable incandescent lamp and is waterproofed so as to allow immersion in water in a glass vessel placed over the alternating magnetic pole. The lamp and coil are so loaded that they freely sink when no alternating field is present. The putting on of alternating current so as to produce a powerful field causes the lamp to rise or float upward with its attached coil to a height such as will maintain a certain brilliancy and at the same time cause a balance to exist between the uplifting repulsion of the coil in the field, and its tendency to sink. Here, then, we have a lamp lighted under water without apparent connection with anything and maintaining a constant degree of illumination while floating, not at the surface, but in the body of the liquid. The insertion of a copper sheet between the glass vessel and the alternating pole screens or cuts off the effect to a large extent.

This brings us to another phase of the subject, for if, in applying the screen in the last experiment, we place it so that it only covers a part of the alternating magnet-pole, it will be seen that the lamp-coil is moved laterally so as to tend to place itself directly over the screening piece. If we now substitute for the lamp-coil a plain ring placed over the copper screen so as to be free to move, it will slip over the screened portion of the pole as if attracted thereto. Indeed we may take two rings of copper and place them together in the alternating field. They will attract each other and, if of equal diameter, will lie parallel as one ring. The double ring will now be repelled from the pole as if it were a single ring. The explanation of the attraction of the two rings is simple. Both are under the same induction and currents are set up in both which are in the same direction at all times. Currents in the same direction produce attraction of the conductors conveying them into parallelism and as near together as possible.

By utilizing this principle we are enabled to secure continuous movements as of rotation around an axis—for we have only so to dispose conducting metal that it shall continuously be attracted towards our metal screen. Placing then a screen or shading-plate over the alternating-magnet pole so as to cover it only in part, we approach the edge of a disk of copper pivoted centrally and free to rotate, so that one side of the disk shall cover the "shaded" pole. It at once begins to revolve and soon rotates rapidly, the movement being such as to bring new portions of the rotating disk constantly over the screen. The phenomenon in reality depends on shifting magnetic fields. The shading-piece or screen retards the development of the alternating polarities in the space near it, while there is no retardation over the unshaded or unscreened portion of the end of the wire core. The effect is the same as if the magnetism continually traveled or shifted

from the clear part of the pole to the shaded or screened part. But lines of force in movement will push conductors with them, and so the disk subjected to such influence is driven continuously. If an iron or steel disk be mounted on pivots, it will also be driven over the shaded pole, but its plane of rotation should be at right angles to that of the copper disk. Both disks may be driven together in planes at right angles. The iron disk is driven by the shifting lines of force as if it were pulled around by a magnet. One copper disk may act as a screen for another and both be set in rotation if they are suitably placed. Similarly, copper and iron disks may react on each other and both be set in rotation. Indeed, it is possible to keep a number of copper and iron disks in rapid rotation by placing them suitably in a single alternating magnetic field. Pieces of steel, tubes of copper, lumps of brass, iron masses, placed in an alternating magnetic field so modify it as to cause shifting magnetism, such that rotations are produced in pivoted iron and copper disks placed near them. An almost endless variety of dispositions may be selected and the results correspondingly varied. Thus the simple placing of a steel file acoss the alternating pole gives rise to shifting lines of force starting at the pole and passing to the ends of the file. Pivoted iron and copper disks placed near the file are rotated accordingly. Magnetic fields may be caused to travel around iron rings, along copper tubes, over sheets, etc., in each case being detected in their movement by the tell-tale rotating disks. The best detector is a delicately-mounted iron disk made up of several round punchings of sheet iron, and provided with an overhanging rim of copper, thus resembling an iron pulley with a wider rim of copper.

We thus see that an alternating magnetic field is truly dynamic in that it not only actively repels closed circuits or deflects them into positions parallel to the lines of force in such field, but also that the introduction into the field of such a simple thing as a piece of conducting metal, or a piece of magnetic substance, brings about laterally traveling or shifting lines of force which may confer rotation or movement even continuously to pivoted pieces of conducting or magnetic metal.

That these principles should fail to find practical applications would be extraordinary. Indeed, the fact is that they are applied in practice in many ways the details of which would be out of place in the present paper. They have been utilized in constructing regulators for alternating currents, arc-lamps, and for self-starting alternating current motors, as well as in the construction of meters for registering the consumption of energy on alternating circuits.

One of the most curious facts brought out in the course of exper-

imentation, an outline of which has been given above, was that a structure of copper and iron, such as the iron disk or pulley with a copper rim, when once set in rotation in an alternating magnetic field, would not only continue in rotation, but increase its speed up to a certain point, even though there existed no shading-piece nor other device in the field to set up shifting lines or traveling field. The copper-rimmed wheel was sufficient unto itself after it was first started in rotation. Similarly, an armature of laminated iron bearing closed coils or circuits on its exterior and placed in an alternating field will, after starting, continue its rotation. Not only that, but with a scientifically-constructed machine the tendency to rotate will not be easily checked by taking power from such armature. This machine is in brief the single-phase induction worked up to a fair degree of perfection in late years. By the employment of commutators which only act during starting or by embodying the principle of the shaded pole, these machines become self-starting in character even under load.

. It has of course required a very large amount of careful, painstaking effort to apply the principles pointed out to the actual commercial needs. This is particularly the case where the machinery has been required to reach a high standard of excellence. Much work will be accomplished in this field in the near future

While, properly speaking, no account of the properties of an alternating magnetic field would be at all complete without a discussion of those particular phenomena which are produced by currents of differing phasal relation acting on the same magnetic medium, we must at present pass them by Otherwise we would be led into a field of work which may well be set apart as special, involving the consideration of the effects of polyphase currents, together with the machines which employ them and which have taken a very important place in power-transmission within the past few years. Neither can we discuss, within the limits of the present paper, the remarkable effects produceable in an alternating magnetic field of high frequency. Such fields are capable of inducing hundreds of volts to the inch of conductor, may even induce currents in a person's body such that an incandescent lamp may be fully lighted if the terminals be taken in the hands, or give rise to electric discharges which will leap distances in air of over five feet. These discharges resemble lightning discharges closely, not only in appearance, but in their destructive effects in overcoming obstacles in the path, yet they are comparatively less harmful to life than our more ordinary electricity at relatively very small pressures or potentials.

It may be said in conclusion that the study of alternating currents and, incidentally thereto, of the magnetic effects of such currents, has widened the field of electric possibility almost without limit, and that

there are at present no signs of abatement of progress in the directions given to electrical research thereby.

Furthermore, the study of the interactions occurring between what may be termed energy storage in an alternating magnetic field and energy storage in electro-static fields, is leading the way to the solution of many great problems. The combination together of the effects of inductance, or magnetism in a circuit with capacity, or electro-static induction, is indeed the field of work which has promise of great results in the future.

DEVELOPMENT OF THE ELECTRIC LOCOMOTIVE.

By B. J. Arnold, M. Am. Inst. E. E.

THE electric locomotive is but one of the many applications of the electric motor. But its early development is so closely allied to that of the motor that it has been thought well to embody in this article a brief history of the latter, drawing attention only to those machines which have marked a decided advancement in the art or such as were applied to the propulsion of cars.

To an Englishman named Barlow belongs the credit of performing (in 1826) the first recorded experiment involving the principle of the electric motor, by illustrating how electricity could be employed as a motive-power by rotating a disk of copper between the poles of a permanent magnet. To Italy, however, must be ascribed the honor of having first excelled in this most interesting scientific field, by producing what is believed to be the first electric motor. In 1830 the Abbé Salvatore Dal Negro, a professor of natural philosophy at the University of Padua, invented a reciprocating form of motor, so arranged that a permanent magnet oscillated between the poles of an electromagnet, the polarity of the latter being changed at each oscillation.

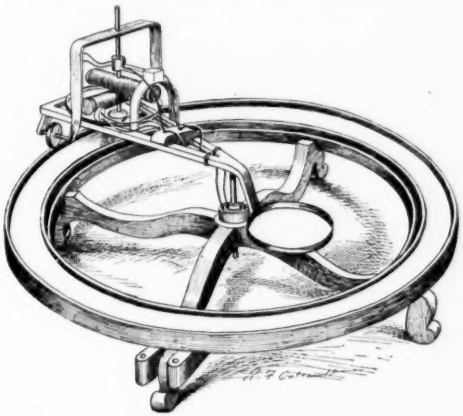


FIG. I—DAVENPORT'S ELECTROMAGNETIC MOTOR.

Thomas Davenport, a blacksmith of Brandon, Vermont, devised in 1835 a motor consisting of a revolving electromagnet, the poles of which were attracted by fixed magnets in which the current was broken or commutated at suitable intervals, so as to attract or repel the magnets of the revolving portion. This device, but little more than a scientific toy, was driven by primary batteries, and was exhibited

in operation the same year at Springfield and Boston, Massachusetts, being the first practical demonstration of an electric car on record.

In 1838, Robert Davidson, of Aberdeen, Scotland, constructed an electric car or locomotive, about sixteen feet long, driven by forty primary cells, which weighed, complete, about five tons. Several trips were made with this on the railways of Scotland with great success. It was eventually destroyed by some miscreant, supposed to be a jealous steam-engineer fearful that this apparently formidable rival might render his calling obsolete.

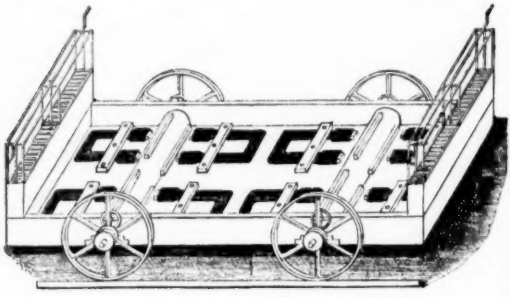


FIG. 2—ROBERT DAVIDSON'S ELECTRIC CAR.

Our own countryman, the late Moses G. Farmer, whose investigations in electricity extend over a wide field, constructed in 1847 an electromagnetic locomotive which was driven by primary batteries, and drew a little car carrying two passengers, on an 18" gage track. During the same year a Mr. Lillie and Dr. Colton of Pittsburgh, Pennsylvania, built an electric locomotive driven by primary cells and operated it on a circular track. In 1850, Professor C. G. Page, of the Smithsonian Institution, constructed an electric locomotive and ran it from Washington to Bladensburg, a distance of five miles, upon the standard-gage track of the

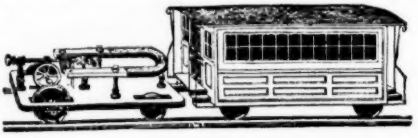


FIG. 3—MODEL OF HALL'S ELECTRIC LOCOMOTIVE.

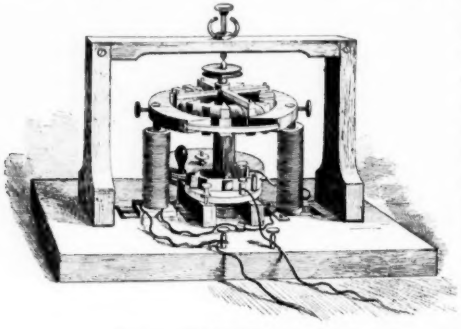


FIG. 4—PACCINOTI'S MACHINE.

Washington and Baltimore road. It was rated at 16 horse-power and employed one hundred cells of nitric-acid battery to drive it. It attained a maximum speed of nineteen miles per hour, but was abandoned on account of the excessive cost of operation.

Contemporaneous with Page's experiment, Thomas Hall, of Boston, built and exhibited a small model of an electric locomotive illustrated on p. 540. The motor consisted of a permanent magnet, between the poles of which revolved an electromagnet, its armature being geared to the axle of the car. All these early inventions of electric cars and proposed electric locomotives were non-productive of commercial results, for the reason that the inventors were entirely dependent upon primary batteries as the source of power, and it was not until 1861, when Paccinoti, the distinguished Italian physicist, made his famous electromagnetic machine, the nucleus of the modern dynamo and electric motor, that the possibilities of the electric railway and power-transmission schemes of the present day were made possible. This machine is shown in Fig. 4. It was described in the Italian journal *Il Nuovo Cimento* in June, 1864, but it was not until 1871, when Gramme brought out his dynamo with the ring armature,

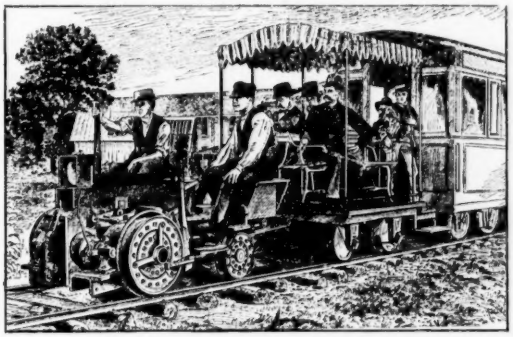


FIG. 5—EDISON'S EARLY ELECTRIC LOCOMOTIVE.

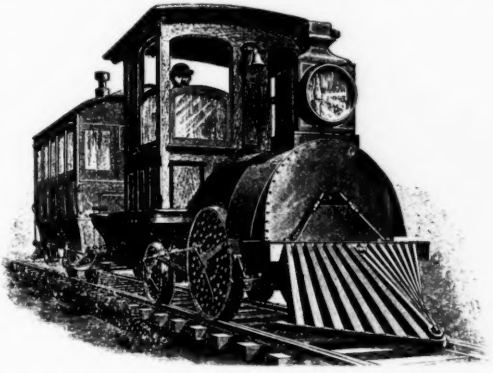


FIG. 6—EDISON'S IMPROVED ELECTRIC LOCOMOTIVE.

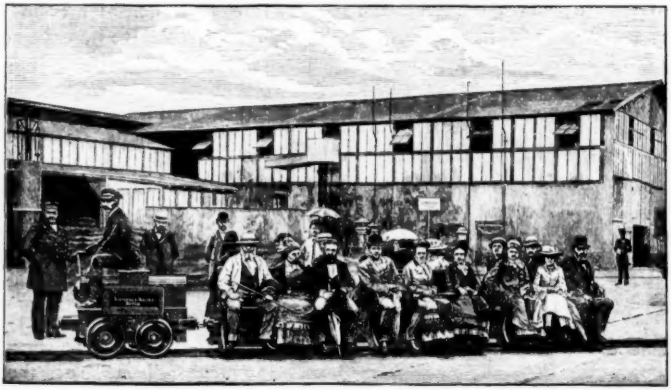


FIG. 7—SIEMENS'S ELECTRIC LOCOMOTIVE, EXHIBITED AT BERLIN IN 1879.

that Paccinoti realized the worth of his own invention, and resurrected it from the museum of the University of Pisa, exhibiting it at the Vienna exhibition of 1873 and the Paris exhibition of 1881. The dynamo was proved conclusively to be applicable as a motor, by Fontaine and Breguet, on June 3, 1873, in Machinery Hall, at the Vienna exhibition. They had intended to install their plant so as to run one dynamo as a motor from a battery, but, owing to the failure of the power, they coupled the two machines together, thus driving one of the dynamos as a motor from the other. From this date the development in all branches of electrical machinery was rapid and from this forward we will confine our attention to the electric locomotive, or railway part of the electrical field.

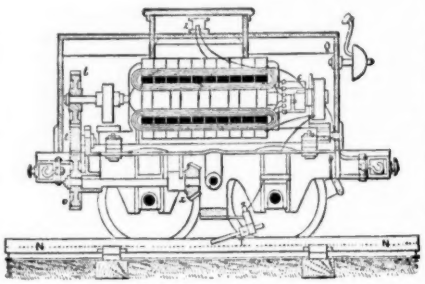


FIG. 8—SECTION OF SIEMENS'S LOCOMOTIVE.

In 1875, George F. Green, of Kalamazoo, Michigan, constructed a small electric car similar in many respects to Farmer's, although somewhat larger. He used the track-rails to convey the current to the moving car, batteries being used for power and small electric motors of the pole-changing type for the propulsion of the car. His drawings

also show that he proposed to use an overhead wire as one of the sides of the circuit. He worked assiduously at the development of his ideas and in 1878–79 built a model large enough to draw two people. He fully understood the advantages of having a dynamo, but none was available, and, as is often the case, poverty prevented him from making application for patents until August, 1879, when, acting as his own patent attorney, he encountered difficulties in the patent office which caused the rejection of his claim. His case was afterwards tried before the circuit court of the District of Columbia and a patent was granted, although this did not come until December, 1891, shortly before his death. The legal ownership of his patents had long since passed out of his possession and it would thus seem that, through poverty, misfortune, and the shortcomings of the patent office, he was deprived of a patent, which, had it been granted at the proper time, might have made his name one of the best known among electric-railway inventors of America, as his experiments seem to form the bridge between the impractical and the practical in electric-railway work.

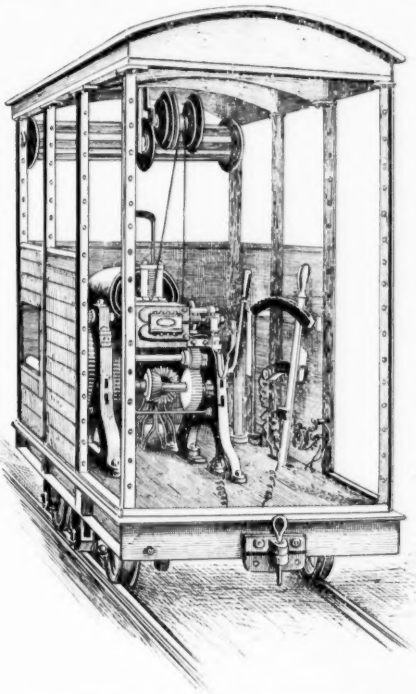


FIG. 9—LOCOMOTIVE DRIVEN BY ACCUMULATORS, LISIEUX, FRANCE.

On May 21, 1879, Stephen D. Field filed a caveat for a patent on an electric railway, which was afterwards granted, although in 1880 Thomas A. Edison had brought out the first practical working electric-railway locomotive in the United States. The interests of Edison and

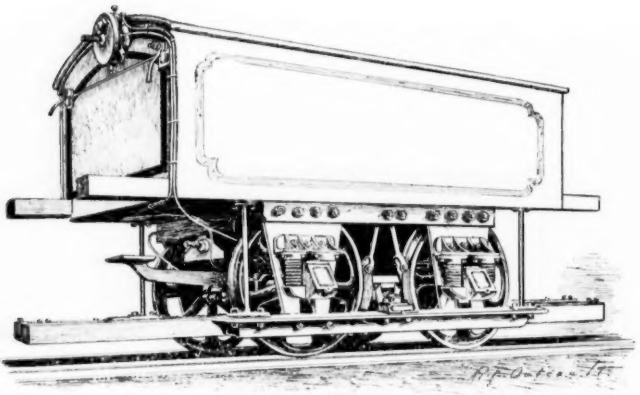


FIG. 10—RECKENZAUM'S MINING LOCOMOTIVE.

Field were in litigation in the patent office for a number of years, the case being eventually decided in favor of Field, but not until after the warring factions had been brought into the same financial fold. The Edison locomotive was driven by a motor connected to the forward axle by a belt, the electricity for the propulsion being obtained from a dynamo similar in design to the motor. Figure 6 shows the Edison locomotive after it had been improved.

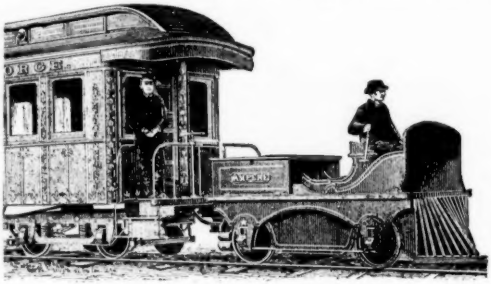


FIG. 11—DAFT ELECTRIC LOCOMOTIVE "AMPERE."

Simultaneously with the work of Field and Edison in America, Siemens, of Germany, who was practically the originator of electric-railway traction abroad, built and exhibited at the industrial exhibition at Berlin, 1879, an electric locomotive which operated a small train of cars upon an oval track about 1000 feet in circumference. Referring to Figure 8 it will be noticed that the armature of this locomotive was mounted parallel with the rails, power being transmitted to the axles by gearing.

While the locomotives driven by means of dynamos and primary batteries were being produced, the storage-battery advocates for elec-

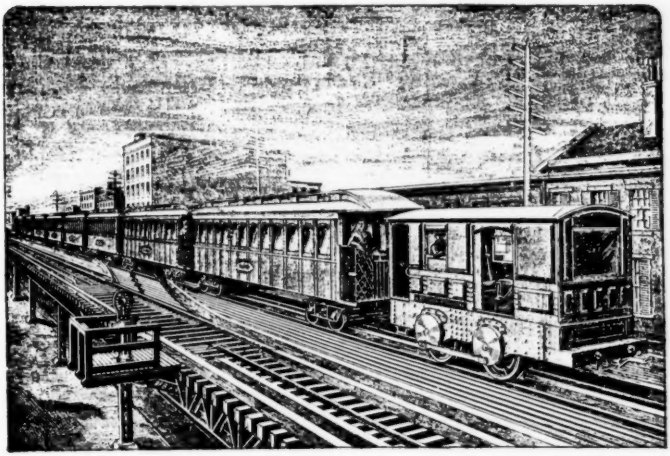


FIG. 12—THE "BENJAMIN FRANKLIN," WITH A TRAIN OF EIGHT CARS.

tric traction were also busy, and during the year in which Siemens produced his model road, a storage-battery locomotive was built and brought out at the linen-bleaching establishment of M. Duchesne-Fourmet, at Breuil en Auge, France (Figure 9). The track was about a mile long and electricity was adopted as the motive-power for the reason that the fabrics to be bleached had to be sent from the factory to the bleaching-fields, and the soot and smoke attendant upon the use of a gas-engine or steam-engine would have been injurious.

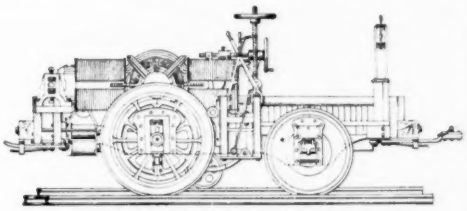


FIG. 13—SIDE ELEVATION OF THE ABOVE.

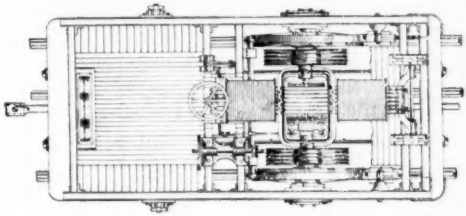


FIG. 14—PLAN OF THE ABOVE.

Storage-battery cars were tried in almost all the leading cities in Europe

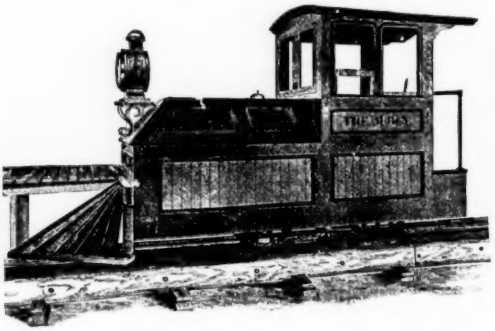


FIG. 15—"THE JUDGE," OPERATED IN CHICAGO IN 1883.

and the United States, between the years 1879-84, but as they were mostly modifications of the ordinary street-car, they would not be classed under the head of electrical railway-locomotives, and illustrations and descriptions are therefore omitted here. One notable example (shown in Figure 10), designed and built from plans of the late Anthony Reckenzaun, an Austrian whose investigations in the electric traction field were extensive, and did much toward solving and bringing into successful operation the electric railway system of the present time, will serve the purpose of this article. This locomotive developed about 8 horse-power and was used for hauling coal in the Trafalgar collieries of England, operating upon an extremely difficult track, having a gage of 2′ 7″, with many grades and sharp curves.

FIG. 16—SIDE ELEVATION.

In 1883 Leo Daft, an Englishman by birth, built an experimental electric railway at Greenville, New Jersey, and a little later operated, on the Saratoga and Mt. McGregor railway, a locomotive called the "Ampere." This machine was ten feet in

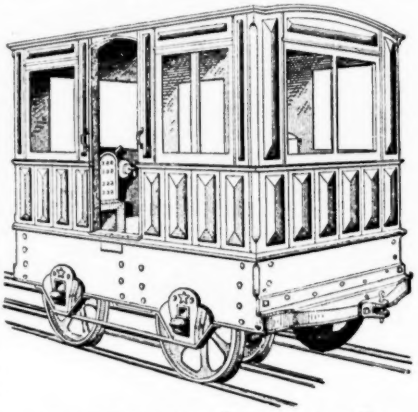


FIG. 17—"THE MORSE," OPERATED IN 1885.

length, weighed about ten tons, and attained a speed of eight miles per hour up a grade of ninety-three feet to the mile. Current was supplied by means of a third rail.

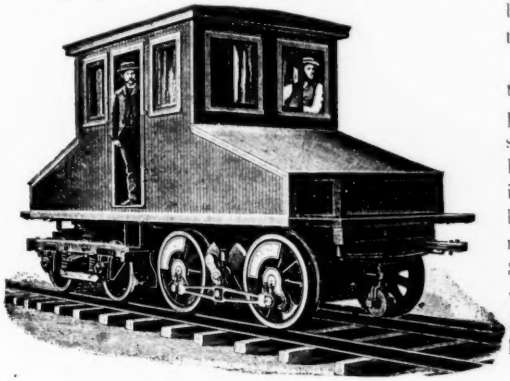


FIG. 18—FIELD'S ELECTRIC LOCOMOTIVE.

Mr. Daft continued his experiments for some years following, his most important work being the experiments in 1888-89 upon the elevated railway in New York, where he operated the "Benjamin Franklin," shown in Figures 12 to 14. It was about fifteen feet in length, weighed nine tons, and, although designed for 75 horse-power, devel-

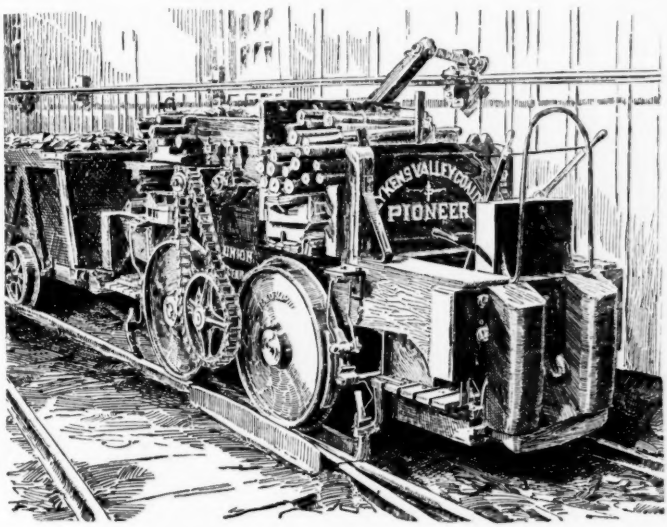


FIG. 19—LOCOMOTIVE ON THE SCHLESINGER ELECTRIC ROAD, LYKENS VALLEY MINE, PENNSYLVANIA.

oped at times as high as 120 horse-power when hauling an eight-car train up a 2-per-cent. grade at 7½ miles per hour. The plant for producing the power being crude and uneconomical, and the motor too light for the work, the experiment was abandoned, thus giving the impression to the railway world that electricity for operating railway trains was much more expensive than it afterwards proved to be. At the Chicago Railway Exposition, in 1883, was constructed the first electric railway built in this country for busi-

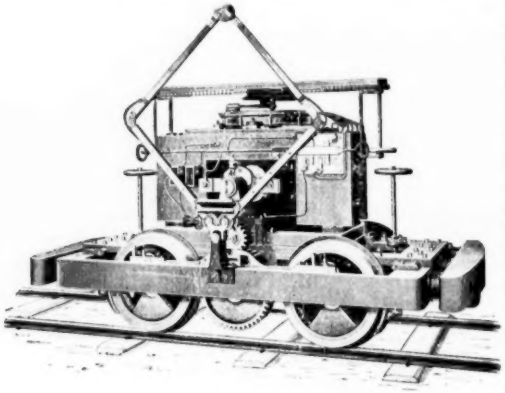


FIG. 20—MINING ELECTRIC LOCOMOTIVE.

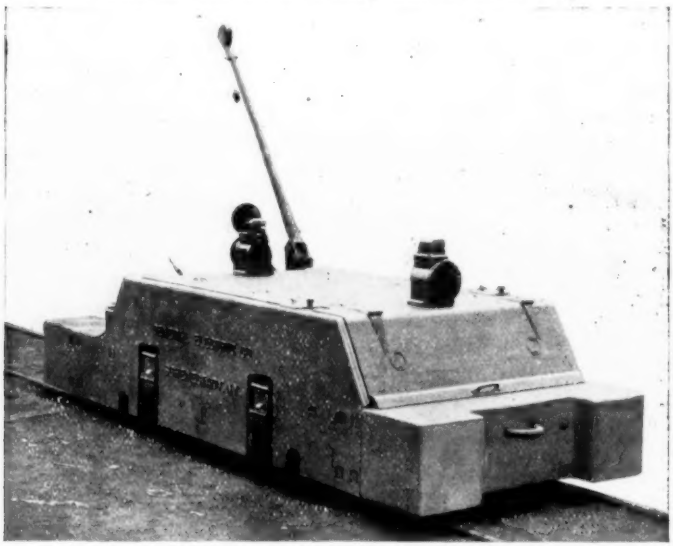


FIG. 21—ELECTRIC MINING LOCOMOTIVE.

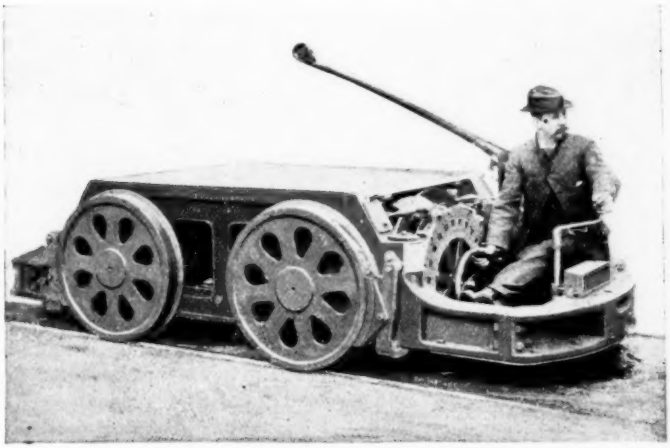


FIG. 22—TWO-MOTOR MINING LOCOMOTIVE, WITH OUTSIDE WHEELS.

ness purposes. This was the first public demonstration of the utility of electricity for railway work, it being the forerunner of the elevated electric road in this country, the culmination of which was realized in the Intramural road at the World's Fair in 1893.

The locomotive (illustrated in Figures 15 and 16) was called the "Judge," and consisted of a platform car about twelve feet over all, supported by four wheels. Upon the platform was mounted a Weston dynamo, the power of which was transmitted to one of the axles by means of beveled gearing and a belt. It was designed by Stephen D. Field and placed in operation by the Electric Railway Company of the United States, which at that time controlled the patents of both Edison and

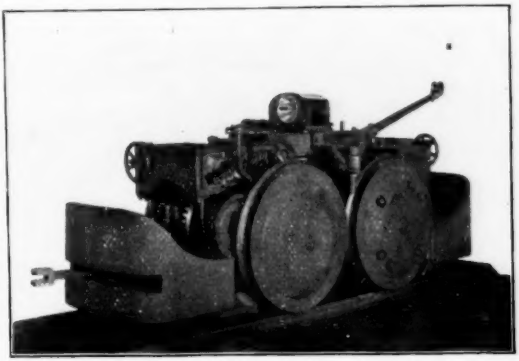


FIG. 23—"INDEPENDENT" ELECTRIC MINING LOCOMOTIVE.

Field. It weighed about 2700 pounds and operated upon a circular track about 1500 feet in length, having a 3′ gage, and carried during the exposition about 27,000 passengers. Electricity now began to attract the attention of many minds and the inventions and experiments in the electric-railway field became so numerous that it is impossible to catalogue them all, and only the most noted trials and achievements will be spoken of.

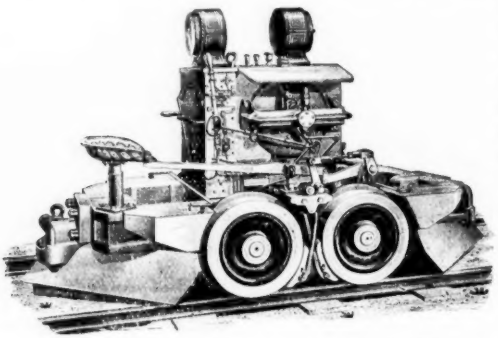


FIG. 24.—JEFFERY ELECTRIC MINING LOCOMOTIVE.

The "Morse" and its counterpart, the "Faraday," were brought out by Daft in 1885, for use on the Baltimore Union Passenger railway. The former (shown in Figure 17) was 12½ feet long by 7½ feet wide and weighed 4200 pounds. Figure 18 illustrates one of Mr. Field's locomotives which he constructed and put in service upon the Thirty-fourth street branch of the New York elevated railway. It will be noticed that the motor is mounted midway between the wheels and directly connected to them by means of side-rods similar to the ordinary steam-locomotive. The series motor was controlled by a liquid rheostat. It was mounted upon 36-inch wheels and weighed about thirteen tons.

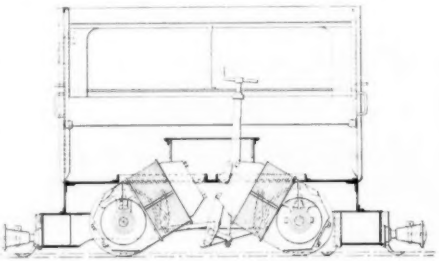


FIG. 25.—ELECTRIC LOCOMOTIVE ON CITY AND SOUTH LONDON RAILWAY.

Extensive experiments were also carried on on the Thirty-fourth-street line by Frank J. Sprague, who, in conjunction with Charles J. Van Depoele, may be considered the most successful pioneer in the application of electricity to the propulsion of cars on the surface street-railways in America.

From the time of the abandonment of the experiments by Daft,

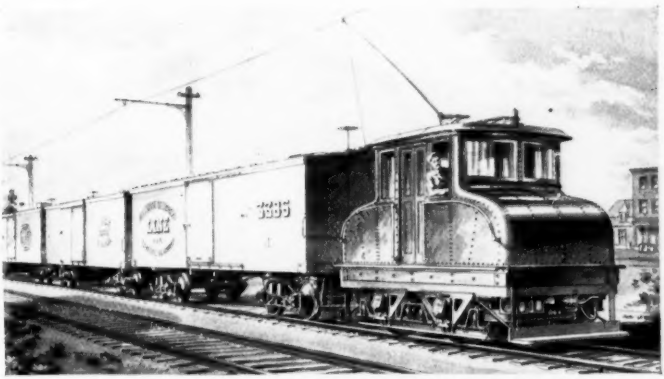


FIG. 26—THIRTY-TON LOCOMOTIVE DESIGNED FOR ELEVATED SERVICE.

Field, and Sprague, the attention of inventors was directed toward the application of electricity to street-railways, and the best testimonial that can be given to their genius and indefatigability is the fact that there are to-day in operation, in the United States alone, over 8000 miles of electric railway, using 18,000 cars, involving an investment of more than $80,000,000.

The application of electric locomotives to mining work in America was inaugurated July 26, 1887, at Lykens, Pennsylvania, by W. M. Schlesinger, with a locomotive designed by him and illustrated in Figure 19. It operated successfully at a speed of six or eight miles per hour, hauling trains weighing from 50 to 100 tons, increasing the capacity of the road to three times its former

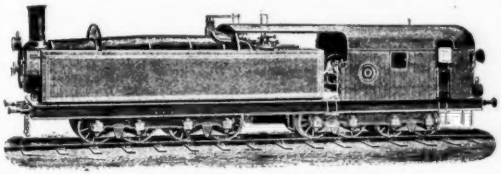


FIG. 27—HEILMAN ELECTRIC LOCOMOTIVE.

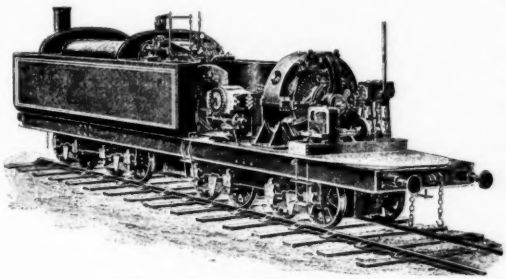


FIG. 28—HEILMAN ELECTRIC LOCOMOTIVE.

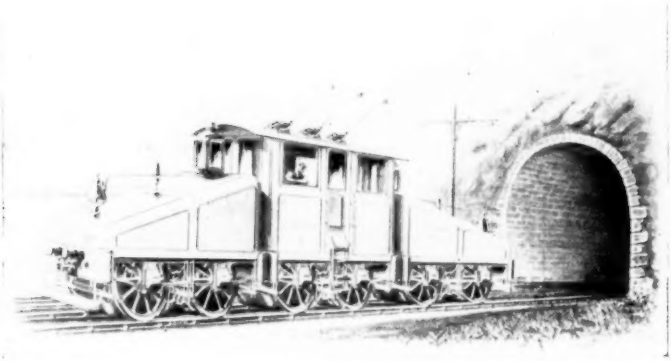


FIG. 29—ELECTRIC LOCOMOTIVE FOR FREIGHT AND PASSENGER TRAINS IN THE BALTIMORE AND OHIO TUNNEL.

output with animal power. The mining industries seem to offer the best inducement for the application of electricity to haulage, with the exception of the surface street-railways, which has resulted in the rapid development of this class of electric locomotives. Figures 20 to 23 show types of the various mining locomotives now built by the leading manufacturers of this class of machinery. The United States are now dotted with many plants in which this silent and invisible power is doing duty in place of the faithful mule, and lessened the cost of haulage from 30 to 50 per cent.

Figure 25 shows a locomotive of the City and South London line, which has now been in operation for about two years with most excellent results. These locomotives are in daily operation, hauling forty-ton trains, at an average speed of 13½ miles per hour, through subterranean caverns in which it would be impracticable to use any other form of power, at an expense of 13 cents per train mile, making the cost per passenger less than with steam-power when the relative weights of trains are taken into consideration.

Figure 26 shows a thirty-ton locomotive designed for elevated

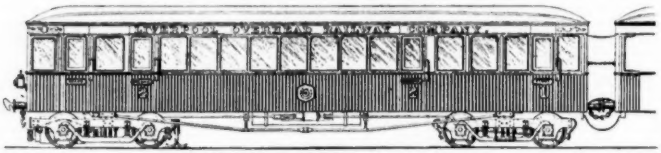


FIG. 30—LIVERPOOL OVERHEAD RAILWAY.

service by one of the leading electric companies. It will strike the reader at once as being very close in general outline to the Field locomotive operated on the New York elevated road in 1883. The principal difference, however, consists in the application of the power and in controlling the current. The armatures of the motors are mounted upon hollow sleeves concentric with the axles. The current is governed by what is called a series parallel controller, which controls the current in starting, effecting a large saving in the amount of power consumed.

The latest claimant for honors is the Heilman electric locomotive, illustrated in Figures 27 and 28. This locomotive has been built from the designs of M. Heilman, in France, and consists of a complete electric-power station on wheels. There is a boiler water-tank electric-generator driven by a compound engine, and a dynamo of 20 horse-power driven by a separate engine for exciting the fields of the large machine. Eight motors attached directly to the axles of the car utilize the current from the generator. The operation is as follows: Steam is generated in the boiler and conveyed to the engine which drives the large generator, the fields of which are excited from the small dynamo. The current from the large generator is delivered to the motors which propel the train. The losses in this machine as a whole are necessarily great, owing to the many conversions, and while it is interesting from a scientific and engineering standpoint, it is safe to predict that it will soon be relegated to a similar place in history as the one now occupied by the famous Fontaine steam locomotive, which, it will be remembered, was built about ten years ago, created a sensation by the extraordinary claims of its inventor, and two years later was sold for scrap at about one-tenth of its original cost.

Figure 29 shows one of a number of locomotives now under construction, to be used in hauling freight and passenger trains through the tunnel of the Baltimore and Ohio railroad at Baltimore. They are designed to haul a maximum load of 1200 tons at speed of fifteen miles per hour, or, in passenger service, 500 tons at thirty miles per hour. They will weigh 100 tons and have a capacity of 1200 horse-power each. The record of these locomotives will be watched with interest, but as they are to be driven from a central power-station in the same manner that the present surface electric railways are operated, there is little doubt that they will prove as successful as their smaller, though equally important predecessors.

The latest and most important applications of electricity to electric traction are the Liverpool overhead railway and the Intramural railway at the World's Fair. Figure 30 shows one of the cars of the former system.

In 1890 representatives of the Metropolitan railway, of London, presented to a parliamentary committee an estimate based upon the results obtained from the Daft experiments on the New York line, of the cost of equipping and operating a large electric railway system, in which they concluded that it would cost 75 cents per train-mile for motive-power alone, exclusive of interest on the investment. In contradistinction to this it is a pleasure for the advocates of electric traction to know that the Liverpool road is now operating six miles of railway with trains weighing thirty-five tons, at an average speed of twelve miles per hour, for eight cents per train-mile, which, after allowing for the difference in weights of trains, is less than one-sixth or a little over of the above amount.

The trains of the Intramural road ran upon a standard 4′ 8½″-gage track supported by a graceful elevated structure. The road was equipped with fifteen trains, twelve of which were in continuous operation, each one being driven by four 125-horse-power motors attached to the axles of the forward car. These trains carried about 6,000,000 people during the Fair, at a cost for motive power of one-quarter of a cent less per passenger, and a saving of over 50 per cent. in fuel, compared to its latest-equipped steam rival operating under equally favorable conditions.

Since the practical demonstration of electric traction at the exposition in 1883, the electrical worker has succeeded in providing almost every city in the United States, having a population of over 15,000 people, with rapid transit, and to-day, conscious of work well done, looks toward the elevated railway as his legitimate field for future triumphs.* We shall probably see the electric locomotive gradually displace the steam-engine in the elevated-railway service, and at no distant day its adoption on the suburban service of our steam-railways. On trunk-lines operating many trains it is now practicable to build power-stations at equidistant places, transmit the current at a high voltage to substations in which will be located either motor-transformers or batteries to convert the energy and deliver it to the working conductor at a safe pressure.

The line of improvement that is most desired in direct-current motors is some means of making them more economical in consumption of current when starting. If this objection can be removed work in the power-station would be much lessened and economy thereby increased.

While the alternating and multiphase systems offer many advantages for the transmission of electrical energy, they have not yet proved

*Since this article was written two large elevated railway companies in Chicago—the Metropolitan and Northwestern—have decided to adopt electricity for motive power. B. J. A.

themselves applicable or able to grapple with the electrical-railway problem, in which many small motors are required to start intermittently with great torque or rotative effect.

The London *Morning Advertiser* of December 7, 1842, in commenting upon Davidson's locomotive, previously described, said: "Such being the progress of experiments, it is not being too sanguine to expect that some lucky genius will at no very remote period ascertain a means of adapting this extraordinary and easily-developed power to supersede steam on railways, at the printing-press, in vessels, at mills," etc.

The truthfulness of the prophecy is shown in the fact that electricity has almost completely superseded steam in operating small printing-presses, has displaced animal power on almost all the surface street-railways, and is rapidly encroaching upon the field of the steam-locomotive. It has not yet supplanted its rival in the operation of large vessels, although its application to small electric boats and launches is rapidly becoming general, and it is safe to predict that before many years shall have passed it will fill its place in this important field, making good the prophecy of the London editor who long since passed from the field of material triumphs.

NOTE.—The illustrations accompanying this paper, numbered Figures 4, 9, 10, 13, 14, 16, 19, and 25, have been reproduced from Messrs. Martin and Wetzler's work on the electric motor and its applications, by the courtesy of the W. J. Johnston Co., Limited, of New York. Figure 1 is reproduced from the *Electrical Engineer* and Figure 30 from the *Western Electrician*.—THE EDITOR.

THE EARLY STEAMBOATS ON THE LAKES.

By J. F. Holloway,

Past-President American Society of Mechanical Engineers.

THE writer readily recalls the time when, as a boy seated on a farmer's wagon and coming over the crest of a hill, he for the first time saw stretched out before him the blue waters of Lake Erie. He does not now and can never again hope to recall the mingled feelings of surprise, wonder, and awe that this first sight brought to him: neither can he explain to himself why it was that the broad expanse of water that lay spread out before him seemed to rise upward on a gradual inclined plane, until, at the extreme verge of the horizon, the blueness of its waves melted into a cloudless sky of like tint. To the boy who had only seen the little mill-pond of the village in which he was born, there was something unspeakably majestic in the vision of the waters before him, which seemingly had no farther boundary than the overhanging sky, and wherein the distant white-winged vessels seemed to float alike in air and in water. Remembering in after years the impressions made on him by this first sight of this inland sea, he could readily understand something of the irresistible fascinations which tempted the boys of forty or more years ago to leave comfortable homes to sail the seas over, to fathom their mysteries, and reach their farthest shores.

Later on, opportunities came for more frequent visits to the near-by and thriving lake port, and for a closer acquaintance with those who were wont to go down upon the sea in ships, and for a somewhat clearer knowledge of the then newer methods of transportation on water with the aid of steam. While the growing lake town had in it many new and strange things to interest and charm a country boy, it was at the riverside and along the docks that he found most to occupy his attention, and most that puzzled him to understand. As there were at that time no railroads in that part of the country, the bulk of the travel westward was by water and through the connecting lakes, and, although vessels propelled by sails had not entirely ceased to convey those migrating from the east in search of new homes on the then boundless prairies of the west, it was the side-wheel steamers that were now doing the most of the business. While these boats were numerous, they were mostly small ones which, if placed beside the great steamships that float in and out of the deepened harbors of to-day,

would seem quite insignificant, but, as compared with the little schooners and brigs they were displacing, they were immense.

In the early days of steamboat-building there was much experimenting as to what was the best kind of machinery to be employed; indeed, so distinctly different were the types of engines used that persons familiar with the different steamers could readily distinguish them when, to an unpracticed eye, they were but dots upon the horizon, and so varied was the drumming of their revolving wheels, and the extent or sharpness of their escaping exhaust steam, that in the darkness of the night or when hidden under a heavy fog they could be named. Some of the boats were propelled through the medium of a walking-beam which projected above the cabin, and to which sometimes there was attached the figure of a galloping steed whose alternate rising and plunging forward was perhaps intended to indicate, not only the taste of the owner or builder and the speed of the boat, but, to some extent, the horse-power of the mechanism to which it was attached. Other boats had what were known as "square engines," which also projected in part above the cabin, but which had in place of the tumbling beam a vertically-moving cross-head, with swinging connecting-rods on each side, attached to the cranks on the paddle-wheel shaft, and which, when in motion, were not unlike a pair of crutches under a lame man, and seemingly for the same purpose of getting ahead. Others were driven by what were known as horizontal engines, which, while they took up a considerable space on the main deck, left the cabin above them a long and uninterrupted saloon which, while adding to the comfort of passengers, gave greater opportunity to the decorative artists of the time in which to show their ingenuity and skill. Many an old-time traveler can doubtless recall the bits of scenic painting displayed on the panels of the long row of stateroom doors, on either side of the cabin, the subjects of which ranged from the ducal palace of a prince on the banks of the Rhine to the rustic ruin of a hunter's camp in the wild west.

The captains of these early and, as their gorgeously-illustrated placards announced, "magnificent steamers," were quite a distinct class of citizens. They were mostly recruited from the ranks of the successful masters of sailing-vessels, and many originally were no doubt either sailors from salt-water or persons who had been trained under sea-captains and who had imbibed their somewhat martinet-like manners. The difference between the captain of a lake steamer and the captain of an Ohio-river steamboat was marked to a degree readily noticeable by any observing traveler. The lake captain, as he walked his deck, was a man not readily approached, and the anxious passenger impatient to reach the end of his journey rarely ventured to

question him as to how much longer he was going to lay in port or when he expected to arrive at the end of the route, preferring to bide his time and procure the desired information from the more approachable first or second mate. Not so with the captain of the Ohio-river boat. Nearly every one along his route knew him by sight or name, and many a signal for him, or possibly for his pilot, was waved from behind half-opened farm-house doors along both banks of the river. When, after the jangling of many bells, the hoarse roar of the exhaust-pipes was silenced and the bow of his boat was pushed well on the bank, he was among the first to go on shore to shake hands with the principal citizens of the town, who at such times usually lined themselves up awaiting his arrival, and to inquire how crops were looking generally, and if the late cold spell had damaged the early corn. As the business for his boat was mainly picked up along the shore, it was to his interest to know what the prospects were, and as well his desire to stand well in the esteem of all.

One of the peculiarities pertaining to the early steamboats on the lakes was the use of the space each paddle-box afforded as a place to be dedicated to paintings of historic events, and the earliest examples of mythological teaching that came to the country boy were the pictures they sometimes exhibited, in which trident-bearing gods of the sea were tangled up in the waves with a breed of horses to him before unknown. On others, the stalwart figure of some well-known Indian chief clad in fringed buckskin and adorned with feathers, sad, yet defiant, looked out over the waters he once called his own. When the name of the boat was a short one, or the name of the line to which it belonged would permit, the letters of which it was composed or the initials of the line were shown there, wrestling with each other in a monogram in which each letter was seemingly striving to get an underhold, and which, taken as a whole, formed a puzzle never to be found out until by chance one heard its mysteries unfolded by some passenger who, standing on the deck near it, with his cane traced out each curve and pronounced its name.

While the travel westward in these times was sufficient to fill all the steamers to their full capacity, there still existed considerable rivalry between them. Each claimed a superiority in speed and accommodations and in the special strength and safety of its boilers, for in those days the use of steam was so recent that many who ventured to travel on vessels thus propelled felt that they were taking great risks. The stories told by the agents of the different boats as they solicited travelers, as to the extraordinary strength of their boilers and the low pressure of steam carried, would sound oddly enough now, when boilers on boats carry steam of 250 pounds pressure, as compared with the 30 or 40 pounds

years ago. The theory of the steam-engine and the apparent complications connected with its use were to many of the passengers so hopeless a problem that they gave up its solution at the very start, while others, more persistent, spent many of their leisure hours between ports in seeking to solve its mysteries. Among the later was a well-dressed, thoughtful-looking man who at one time was a passenger on a somewhat famous boat in its day, in which the propelling power consisted of a row of return-flue boilers down in the hold, and a single horizontal steam-engine in plain view on the main deck, directly connected to the cranks on each paddle-wheel shaft. With so much in plain sight, it would seem that little or no explanation would be required by any observer, but with a belief no doubt that there were other necessary and hidden mechanisms, this would-be scientist spent many hours of several days in watching the operation of the machinery and in tracing out the sequence of its motion.

Standing near the steam-cylinder, he would watch with interest the alternating movement of the piston-rod with its attached cross-head, and the long iron-strapped wooden connecting-rod reaching forward to the paddle-wheel shaft, noting with care how its swinging end seemingly turned the cranks to which it was attached. He would then turn back to the steam-cylinder, apparently to trace out some unseen or overlooked appliance believed to be essential for the work to be done. Finally, after several days of silent contemplation and with an unsatisfied expression on his face, he ventured to approach the person in charge and the following conversation was had :

"I beg pardon, sir, but I believe you are the engineer of this boat," said the passenger, to which the somewhat grimy man with an oil-can in his hands briefly replied, "I am."

"Well sir," said the well-dressed stranger, "I am very much interested in mechanics, and have given the study of the steam-engine much thought, and am quite familiar with the generation of steam and its application to machinery generally, but there are some things connected with the application of steam to the propelling of boats that I cannot quite understand, and I will be greatly obliged to you if you will kindly give me the required information."

"All right," said the engineer, as he reached forward to dope a suspiciously dry looking spot on the main slides; "fire away. What is it?"

"Well," said the stranger, timidly, "there are your boilers," pointing to the two smoke-pipes which on either side of the boat passed up between decks; "I understand all about them, and here is your cylinder, and that is all clear to me, but what I cannot quite make out is where does the steam strike the paddle-wheels?"

This was a stunner for the knight of the starting-bar, who no doubt had never passed a civil-service examination, but, after scratching his head with his unemployed hand, he replied: "Well, the fact is, stranger, I have only been on this boat but a short time, and I'm —— if I know."

Equally crude were the ideas entertained by many persons as to the power developed by steam-engines and boilers, and as to the methods by which their power was ascertained. As the early-built steam-engines were mostly used to take the place of horses in driving machinery, it was usual to rate them by the number of horses they displaced, and thus the term "horse-power" became not only convenient, but common. At the time referred to no steam-indicators had been invented or used, or, if they had been, they had not then penetrated the backwoods of the west.

The bright young student fresh from some technical school, with his little black walnut box filled with shining wheels and springs, who now goes about the country and at such short notice will take a diagram from your engines, and, with a few adjustments of his pocket slide-rule, tell you not only what the horse-power of your engine is, but what it ought and will be if you will permit him to adjust its parts, was then an unknown product, and no doubt had he then appeared, in advance of his time, he would have received but scant courtesy from the old-time engineers who received book-learning only at a heavy discount.

Illustrating a simpler and equally graphic method of computing the horse-power of a steam-engine and boilers, was an incident that came to the knowledge of the writer at a time when, as he then thought, there was nothing left for him to learn about steam-engines and boilers, or their attachments.

The steam-boiler of the era to which reference is made was a crudely-constructed affair, and the boiler-shops in which they were built, when not under a tree, were housed at best by a rickety shed. Beyond a simple hand-lever punch with which to perforate the holes in the plates to receive the rivets, it had few tools other than a hand-hammer and a sledge, and of course the inevitable drift-pin. As the rivets were then headed cold, the principal tool used was the sledge, although a few artistic boiler-makers did employ a button-set, to take out some of the worst dents left by the hand-hammer. That boilers thus built would require the aid of some extraneous substance in order to enable them to hold water will be readily conceded by those who are familiar with their use.

There had been built at the lake port previously referred to a steamer which, in size, power, and model, was expected, as the builder

said, "to take the broom." Of course the boilers and engine had received especial care in their design and construction, and were expected by their extra power to supplement any errors in the model or hull that might be developed. The boilers had been placed in the hold of the boat, the engine lined up and connected, and the eventful trial of both was near at hand. The day had passed and gone, and the shades of evening were fast falling along the river and on the now nearly-deserted boat, when a two-horse wagon loaded with the by-product of a livery-stable drove into an alley leading to the dock to which the boat was secured.

With discreet celerity a transfer of the content of the wagon was made to the hold of the steamer, where it was evenly distributed within the boilers; after this was done, the boilers were closed up and pronounced completed and ready for use.

During this time an observant stranger, doubtless also a seeker after knowledge, had been lounging about the dock intently watching the proceedings, but with a much-puzzled air. After it was over, and as he stood by himself fumbling his frouzy whiskers, he was heard to say: "Gosh! I've heerd a good deal said about the hoss-power of bilers, but I never knew before how they got at it, but I see it now; they reckon it by the quantity of hoss-manure they put in 'em."

As the years passed by, the approaching railroads from the east and from the west narrowed down the intervening water-route until from Buffalo, at one end of Lake Erie, to Monroe, Michigan, at the other, was all the space left to be covered by steamboats, and for this the railroad companies built and equipped a line of large and fast side-wheel boats, which in point of speed and elegance equalled anything then afloat on the Sound or the Hudson river. Here and there you may yet come across a quiet, gray-haired man who, as captain or engineer, sailed on these now well-nigh forgotten floating palaces, and if you evince an interest in them, and especially if you have any knowledge as to their performance, his eye will light up and his face brighten with pleasure, and if he be in the proper mood he will rehearse tales of gone-by experiences that not only will interest and delight you, but will convince you that, if wisdom did or did not all die out with the men of the past, it certainly did not all come in with the men of the present.

While the change from the railway-cars to the steamboats was a pleasant one during the warm months of summer, it was not always so in the spring and in the fall, and of course in the winter their place was filled by the stage-coach along the southern shore of the lake, but soon through the forest and among the newly-cleared farms, the new-laid iron rail made a connecting highway over which the iron horse

speedily moving onward sent back a defiant challenge to the slower moving steamboat which was soon to be relegated to the past, as had been the sailing craft and the birch canoe of the Indian that had preceded them. The side-wheel boats of which this is a brief account have long since passed away. Their hulls stripped of cabins and machinery, they for a time served to transport lumber, etc., but time with its remorseless tooth has long since eaten out their symmetry and strength, and in out-of-the way places they lie moldering on the banks, or are sunken beneath the waves above which they once so proudly floated.

In great cities of the west are living yet first settlers who readily recall trips made on these early steamboats, and matronly grandmothers will tell to listening children stories of the gaiety and fashion displayed within their brilliantly-lighted saloons, when, after supper, the well trained-waiters formed a band whose music filled all the space with scenes of mirth and revelry, unknown to travelers of the present.

In the village graveyards that line the shores of these inland seas lie many of the men to whom was entrusted the comfort and safety of the great number of persons who in those early days sought in the then far west a home for themselves and their children. As one who knew something of the lives of these men, and of the hardships and perils to which they were exposed, and of the responsibilities that rested upon them as captains, engineers, and officers of the early steamboats on the lakes, the writer desires to testify to their many good qualities, and to say that as a class they were rarely excelled in the conscientious performance of their duties. Often unlearned as to the courtesies of life or in the refinements of social usages, they had in them the stuff of which heroes are made, and when occasion required, as it often did, they displayed an unselfish heroism which, more widely known, would have brought to them the recognition and fame they well deserved but rarely received.

ELECTRICITY

Conducted by Franklin L. Pope.

WITHIN the last two or three years there has been a marked tendency towards the use of the largest possible dynamo units in arc lighting, as well as in incandescent lighting and railway work. But the peculiar difficulties to be surmounted in the case of an arc machine of great capacity are much more perplexing than those which are due to mere size. In the low-tension machines, the difficulties are principally those of mechanical design and proportion, but in the case of the arc machine, the working potential increases at the rate of 50 volts for each additional lamp, and thus the pressure soon reaches a limit beyond which, under ordinary conditions, it becomes wholly unmanageable. Tests have recently been made of a new arc machine of the Excelsior type, which has successfully withstood the enormous potential of 10,000 volts at full load, with a current of 10 amperes and a speed of 625 revolutions per minute. The machine will supply 200 lamps of 2000 nominal candle-power each, and weighs, complete, 16,000 pounds. One of the peculiarities of the design is that the armature-shaft is carried in a single central bearing. The success of these huge machines appears likely to create something of a revolution in the practice of large central stations, as it seems to be the universal opinion of central-station men that the largest practicable units are by far the most economical, not only in first cost of machinery and of line per lamp operated, but in proportionate cost of attendance and repairs as well. It is not many years since a central-station man would have been aghast at a proposition to carry a potential of 10,000 volts upon an arc-lighting circuit, but in this respect, as in many others, the electrical world is making rapid progress.

AT a recent meeting of the New York Electrical Society W. S. Hadaway, Jr., read a carefully prepared and exceedingly instructive paper on the engineering aspects of electrical heating. The application of electricity to the heating of street-railway cars has frequently been referred to in this Department, and there has been more or less discussion as to whether or not it is profitable for a railway company to heat its cars in this way, some having contended that it would be much more profitable to sell its electric power at 2 cents per kilowatt and heat its cars in the old way means of coal-stoves. Of course the cost of electricity per horse-power per month, as delivered to the car, is a somewhat varying quantity under different conditions, but in some instances it has been figured out as low as $2. Mr. Hadaway says that experience during the past winter has shown that a surface of 27.5 square feet of black or dull bronze radiating surface is sufficient, when raised to a temperature of 135° F. above the surrounding air, to adequately warm a well-built 20-foot car, and this temperature may be continuously maintained with an expenditure of electrical energy of 100 watts per square foot. On the basis of $2 per horse-power per month, therefore, the cost of operation would figure out about 27 cents per day for each car. But in practice it is not found necessary to run the whole radiating apparatus for a considerable portion of the time, and therefore the average cost is reduced to about 20 cents per day. It is conceded that a coal-stove costs about 15 cents per day to maintain in operation, besides which it occupies the room of one paying passenger. The electric heat is far more uniformly distributed than that of the stove can possibly be, and is incomparably more healthful and agreeable in every way.

REFERRING to the practical aspects of

electrical cooking, Mr. Hadaway states that, under existing conditions, electrical heat can be delivered from central stations at an efficiency of 7 per cent. as against 4 per cent. from coal burned direct in a kitchen range, from which he concludes that, if the problem of boiling water were eliminated, electricity would be considerably more economical for cooking than either coal or gas. But even conceding the cooking by electricity to be considerably more expensive than by direct combustion, the advantages attendant upon its adoption appear to be sufficient to compensate for a wide disparity in price. A prominent hotel-man has stated that if the cost of electricity for cooking were even four times as great as that of coal, it would be found advantageous to use it on account of its cleanliness, great facility of regulation, and uniform temperature, to say nothing of the cooler kitchens and better general work. A hotel installation now in successful operation in New York city is described as comprising an oven of two compartments, a broiler of three sections, portable stoves of various sizes, tea-kettle and farina boiler having independent heaters directly attached, and a plate-warmer. Culinary operations are carried on beneath a hood ventilated by a fan driven by a small motor, and the kitchen is found to be very comfortable as a dining-room. At 5 cents per horse-power-hour, which is a rate quite within the limits of commercial possibility for daytime service, the cost of electricity per person per day would be only about 2 cents. It ought to be possible, in most cases, to furnish current from a water-power station, where one is available, as low as 2½ cents per horse-power-hour in the daytime, which would bring the cost per person per day down to about 1 cent.

A TROLLEY system, arranged upon the well-known three-wire system used in many of the electric stations installed by the Edison companies, is described by A. C. Balch in a recent number of the *Street Railway Review*. The wiring of the car, the overhead construction, the track, and in fact the entire installation outside the power-house is in accordance with ordinary usage. Each feeder, or set of feeders, supplies a separate section of the trolley-wire, which is insulated from the adjacent section in each direction. The track fulfils the electrical conditions and functions of the neutral wire in the three-wire system. Each alternate section of the trolley-wire is of opposite polarity, there being a difference of potential of 1100 volts between each two adjacent sections. The station installation corresponds, in its details, with the usual practice in three-wire lighting stations, except that it is of course not necessary to use potential-regulating devices on the feeders. The operation of the dynamos is precisely the same as in ordinary railway installations. Among the advantages of this arrangement, as enumerated by Mr. Balch, are a saving of 50 to 60 per cent. in copper in the original installation; a complete metallic circuit, and, thus far, an apparently complete exemption from any electrolytic action upon the gas- and water-pipes. Two years experience under the ordinary conditions of electric-railway work have apparently failed to develop any inherent disadvantages in the system. With some modifications, it would seem as if this plan might be admirably adapted to suburban electric lines of greater than ordinary length.

SOME very successful trials of considerable duration have been made of an apparatus for electrically lighting a private car by power taken directly from one of the axles of the truck, supplemented by a storage battery of moderate capacity. The dynamo is mounted on the truck in almost exactly the same manner that the motor is mounted on a trolley-car, being sleeved to the axle at one end, and attached by a stirrup support to the truck-frame at the other. The mechanical connection between the armature and axle is made by spur-gearing, in which particular it also resembles the mechanism of a trolley-car. The dynamo is compound-wound, with the direct and shunt windings in opposite directions. The resulting differential field is nearly constant for all speeds; it acts,

in fact, as an automatic governor and keeps the electromotive force nearly constant. It is said that experience has demonstrated that the output of the machine varies less than 5 per cent. between speeds of twenty-five and sixty miles per hour. An automatic cut-out and pole-changer are provided, the office of which is to disconnect the storage-battery from the dynamo when the speed falls below twenty miles per hour, or the train stops, and to take care of the polarity when the car (and consequently the dynamo) is run backwards. The storage-battery is designed to have sufficient capacity to maintain the lights for six hours without the assistance of the dynamo. The total weight of the electrical equipment, including dynamo and batteries, is about 1000 pounds, and the cost of fitting up a car is said to be in the neighborhood of $650. If this plan is well worked out in its details, as it certainly appears to be in this instance, there would seem to be no reason why it should not furnish an ideal method of lighting railway-cars. The general conception is of course old, but some of the details of the present arrangement display no small amount of ingenuity and adaptation.

In a paper recently contributed to the *Electrical Engineer*, Messrs. Edwin J. Houston and A. E. Kennelly have discussed the practical aspects of the problem of long-distance transmission of electric energy from the plant at Niagara Falls. Some of the assumptions made by these gentlemen are undergoing severe criticism from electrical engineers, but the conclusion deduced is, that the possible limit of distance to which an aggregate of 50,000 kilowatts or more of energy can, in the present state of the art, be profitably transmitted, is something like two hundred miles. Everything depends, of course, upon the maximum voltage which it is found to be practicable to employ, and this has been assumed by the authors at 50,000 volts. It is very doubtful if anything like this pressure has ever as yet been actually used, though it is asserted that 30,000 volts were successfully applied in a portion of the Frankfort-Lauffen experiments. The paper is a very suggestive one, and has given rise to an interesting and instructive exchange of views among progressive electrical engineers.

Mr. Charles E. Emery points out that the very low price assumed per horse-power capacity of motors, generators, and transformers, is one of the principal elements which make electrical transmission through such a long distance appear commercially practicable. His own estimate is that the total cost of the translating machinery at the receiving station will be more nearly $35 per horse-power than $15, the figure adopted by Houston and Kennelly. Upon this basis, Mr. Emery finds that Buffalo will be within and Syracuse without the circle of economical transmission for a 10-hour day, but that for a 20-hour day, both cities will be included within it. Manufactories requiring power for twenty-four hours per day can however most profitably be located directly at the Falls. Professor W. A. Anthony contends that, upon the assumptions of cost of lines and apparatus adopted by Houston and Kennelly, power cannot be delivered at Albany, even with an initial pressure of 50,000 volts, at a price competitive with steam, unless the machinery is operated continuously at its full capacity. The figures of cost are also questioned by Messrs. F. B. Crocker and C. F. Rittenhouse, who express the opinion that the cause of long-distance power-transmission will not be helped by assuming the lowest possible costs and the highest possible efficiencies. Estimates on new and untried schemes should be allowed the most liberal margin possible. Mr. J. B. Cahoon, an engineer of large experience in power plants, makes the general criticism that a factor of safety of at least two ought to be introduced into the calculations of Messrs. Houston and Kennelly. Mr. H. Ward Leonard observes that all the figures are based on an assumed sale of 119,000 horse-power, and that, in order to produce this maximum load, some 300,000 horse-power must be sold, as represented by the aggregate rating of motor capacity, and remarks, very pertinently, we think, that this amount of power is not likely to be disposed of this year or next.

He further expresses the opinion that a power-plant using triple-expansion engines and located on the water-front in Buffalo, will be able to compete commercially with power tranmitted from Niagara. Messrs. Houston and Kennelly have replied to a number of these criticisms, and, at the time of writing, are maintaining their original position with a good deal of spirit. Most of these comments and criticisms have appeared in the columns of the *Electrical Engineer*, and taken together, they certainly form a most valuable addition to the body of existing literature relating to long-distance power-transmission.

AN electrical engineer in Chicago has been for some time engaged in the perfection of a road vehicle to be propelled by electricity, and, according to the published accounts in the technical journals, his efforts have been crowned with a considerable degree of success. The vehicle is a two-seated surrey wagon, built with reference to strength more than to unusual lightness. A motor of 2 horse-power is carried in a steel frame between the front and rear axles, and is coupled to the rear or driving axle by a geared intermediate shaft and sprocket-chain. Twelve cells of storage-battery furnish the motive power, six being placed under each seat, and are designed to furnish sufficient current for a run of 60 miles under average conditions. The total weight of the entire outfit is given as 1270 pounds. The average consumption of energy on level city streets, taking the condition of the pavements as they are found, is said to be less than 2 horse-power at a speed of ten miles per hour. At the schedule rates at which electricity is supplied in Chicago, it would appear from this statement that the cost of current sufficient to make a daily trip of fifty miles would not exceed $10 per month, which, as most of us who have tried it are well aware, is rather less than it costs to furnish provender for a horse. In fact, what with electrical vehicles and the superior telford roads which we are certain to have within a few years, it begins to look as if that noble animal would soon become an article of mere luxury rather than of necessity. It certainly appears as if the Chicago engineer had brought the matter of road transportation by electricity very nearly to a commercial basis.

DR. TALMAGE'S Brooklyn Tabernacle having been destroyed by fire for the third time, the usual attempt has been made to attribute the disaster to electricity. Upon the occasion of the last preceding fire, it was claimed that the wires had been "struck by lightning" and had set the switchboard on fire and so the church, but, unfortunately for the propounders of this theory, the switchboard was ultimately recovered from the ruins, having escaped the general destruction, and proved to be intact, bearing not the slightest traces of any such casualty as had been alleged. The investigation which followed the last fire proved, in an equally conclusive manner, that electricity had nothing whatever to do with its origin. This however will make no difference; it will doubtless always be said that the Tabernacle was burned by electricity, and we shall be much surprised if it does not hereafter figure in the tabular annual statements of losses chargeable to that agency! Electricity, or, more properly, defective wiring, has fires enough to answer for, without being wrongfully charged with those of which it is innocent. The National Board of Underwriters has taken the ground, and not a moment too soon, that all wires out of sight should not only be thoroughly insulated, but should be placed in tubes, so as to be always accessible as well as protected.

THE village of Jamaica, N. Y., is lighted by a system of small electric arcs, which presents a number of features of technical interest. The current used is only 4 amperes, as against 10 amperes for the ordinary full-arc and 7 for the so-called half-arc. Two dynamos are in use, each carrying 70 lamps at a terminal potential of about 4000 volts. Each lamp is fitted with a single pair of plain half-inch carbons, which will burn from 15 to 16 hours —long enough for an all-night run. This system appears to be particularly well adapted to the use of towns in which the

streets are heavily shaded, a condition of affairs which renders the use of the larger arc lamps uneconomical. In the operation of the Jamaica plant, it is found that three of these small lamps require a trifle under one horse-power, which in view of the excellent distribution of the light would seem to make it an exceedingly economical and effective arrangement.

IT has always seemed to us that the schedule of rates for telephone service in our large cities has heretofore been arranged upon an eminently inequitable basis, in that one making use of this convenience only a few times per week has been compelled to pay exactly the same amount as another party who makes use of it perhaps a hundred times as much, so that the annual charge per subscriber, while certainly not excessive when computed upon the basis of the total number of communications passed through the exchange, has been practically prohibitory to a great number of persons who would gladly provide themselves with the service if the payment could be in some sort of proportion to the use made of it. The Metropolitan Telephone and Telegraph Company of New York announced a new schedule on June 1, in accordance with which future applicants for telephone service may have the option of paying somewhat in proportion to the service required. The minimum annual rate will hereafter be $100 for a station on a two-party line, or $150 for an individual line. The former price will entitle the subscriber to 700, and the latter to 1000 connections per annum. The rate for additional connections will be $12 or less per hundred, according to the amount of extra service. An additional reduction will be made on extra business when contracted for in advance. A charge of $15 will also be made for installing a station. The character of service under the revised rates will be in all respects the same as under the arrangements heretofore existing. This step has doubtless been encouraged by the extensive use which has been made by transient customers of the one thousand or more "pay-stations" which have been established throughout the city during the past two or three years, and which have proved to be a very great popular convenience.

IN one of its recent issues, the *Electrical Engineer* publishes in parallel columns two illustrations, reproduced from photographs, showing typical examples of electric-power line construction in Europe and America, which furnish an instructive opportunity for comparison to those who are wise enough to appreciate it. One is the eighteen-mile line from Tivoli to Rome, Italy, which is constructed with steel poles, each formed of two T-bars 21 centimeters wide and firmly bolted together. These are placed 30 meters apart—a little less than 100 feet—and carry four twelve-strand copper cables, each 2.6 millimeters in diameter, besides two silicon-bronze service wires 2 millimeters in diameter. Oil insulators of white porcelain mounted on steel brackets serve to support the wires. The other line is an example perhaps somewhat above the average of the usual style of construction adopted in this country, consisting of heavy wooden poles with pine cross-arms strengthened by light diagonal iron bracing, in the manner employed in the telephone lines, and fitted with green-glass insulators set upon wooden pins. Of course it is cheaper, both in the short run and in the long run, to use the wooden poles and arms, as the interest on the more costly steel construction would doubtless amount to more than enough to replace the wooden construction every twelve or fifteen years, but we cannot see why the same argument should not be equally applicable for example to the flumes and penstocks of the hydraulic machinery. Only the other day we had occasion to examine a recently completed electric-power plant, in which the dam, head-race, tail-race, and foundations were all of massive masonry of most admirable construction; the penstocks and conduits and wheel-cases were of iron, and the construction and fittings of the power-house were in every respect strictly first-class, while the line on the other hand was carried on cheap and slender wooden poles, not strong enough even for a good tele-

graph line, with ordinary sawed cross-arms and wooden pins, and glass insulators to match. The incongruity was really painful. No doubt the electric fluid will run as freely, at least for a time, over this line as over a better one, but still it does seem extraordinary that the same permanent and excellent style of construction employed in the power-house should not have also been maintained in the one part of the work which is principally visible to the public, and which at most would not constitute 5 per cent. of the whole cost.

WE have never seen in this country a single example of strictly first-class overhead line construction. That of the electric railways in some instances comes very near it, and some of the recent construction of the telephone companies is but little amenable to criticism, in view of the purpose it is intended to subserve; but as to the electric-light and -power lines, almost none of them, so far as our observation has extended, are more than fairly good, while a majority of them are about as bad as they well can be. One would think that the line was a factor of sufficient importance in a system of electrical distribution to be worthy of more attention than has hitherto been bestowed upon it, but for, some reason or other, it seems to have been tacitly admitted that any common laborer knows enough to set poles in the ground and hang wires on them, and that any kind of cheap stuff furnished by the dealers in supplies in the way of fixtures and fittings will do well enough.

THE subdivision and distribution of artificial sources of illumination, although a problem which has become of the highest practical importance, appears to have failed to have received the amount of consideration to which it is entitled. We are very glad to note that it has been taken up by so competent an authority as Professor W. A. Anthony, who, in a paper read before the annual meeting of the Institute of Electrical Engineers, has laid down some of the leading principles necessary to be kept in mind in designing a system of illumination which shall give the best distribution of light at the least cost. In this paper he shows that the usual method of dividing the area to be lighted into imaginary squares, and estimating from a source of light in the center of each square, falls very short of fulfilling the conditions required. In a rectangular area treated in this manner, the corners of a large space may receive less than one-third the intensity of illumination that the central portion does. Comparing arc and incandescent lamps as sources of light, upon the basis that the minimum illumination shall be the same in each case, Professor Anthony finds that the efficiency of the arc lamp has been in popular estimation, greatly overrated and he reaches the conclusion that unless the area to be lighted is so large as to require 500 incandescent lamps uniformly distributed, the use of full arc lamps consuming an equal amount of energy will leave some parts of the area less fully illuminated. The use of arc lamps for street-lighting, located at intervals of 1000 to 1600 feet, as they are often seen in pretentious villages and suburban towns, he regards as a great waste of money, inasmuch as the same power employed to operate incandescent lamps at intervals of 100 to 200 feet, would give a better illumination for practical purposes.

THE usual annual bill for the establishment of a government telegraph has been introduced into congress. The present project is opposed by Postmaster-General Bissell, on the indisputably correct ground that it would be certain to add enormously to the annual deficit of the department without correspondingly advancing the interests of the public. It has always been a mystery to us, and one which we have been wholly unable to solve, why the workingmen's organizations should feel called upon to declare in favor of a government telegraph. Why should the workingmen, who so seldom use the telegraph, tax themselves for the purpose of furnishing telegraphic service at less than cost for the benefit of the wealthy business firms and corporations from whom the telegraph companies now derive at least 90 per cent. of their total revenue?

ARCHITECTURE

Conducted by Barr Ferree.

THERE are many kinds of architects. There is the successful architect, the unsuccessful architect, the satisfied architect, the soured architect, the good architect, the bad architect, the artistic architect, the sensitive architect, the engineer-architect, the trumpet-blowing architect, the carpenter-architect, the professorial architect, and the École architect. No especial significance is intended in the order in which these names are set down. The variety is large and interesting, and, if architects were marketable commodities, it would be possible for a purchaser to have choice of a great diversity of brands. The differences are not always great. Some of these classes run very close together. The unsuccessful architect and the soured architect, for example, are usually found united in one person in a union more complete than that which joined the twins of Siamese memory. The successful architect is often the same as the satisfied architect, though it is easy to conceive a difference. The diversity of architects is, in fact, quite as great as diversity in styles. We have good and bad architects just as we have good and bad styles and good and bad buildings in them. But the degrees of good and bad are not continuous through the three series. Good architects often produce very bad buildings, and good buildings will sometimes be done by bad architects. It is true that neither of these cases is usual, but certainly some astounding examples of the former might be named. The carpenter-architect is now an almost extinct species. He is to be found chiefly in the smaller cities and towns, where his light, while not always hid under a bushel, is still tolerably well eclipsed. Few new specimens of this species are grown nowadays, and collectors of architects would do well to capture such as may not be already placed in museums. There is sure to be a rise in their value the moment they become wholly extinct. Still, the carpenter-architect performed yeoman service in his day, and, though we may despise him now or look upon him with friendly curiosity, he should not be viewed with too great contempt. We do not need him now—his day is past. In his stead has come a motley group representing all phases Some of these have been named at the beginning of this paragraph.

THE successful architect is a proud creature. It does not matter whether his success has come through desirable and influential relations or through his own exertions. The former is more likely to be the case, and every ambitious architect who would be successful would do well to maintain a social department in his business. The social element is to the architect very much what full page advertisements are to the dealer in dry-goods. It is even more important than a well-equipped drafting-room. The successful architect is usually fully alive to his success and the fullness thereof. We have met specimens of the class who were looking forward to further heights to climb, additional triumphs to achieve. These are admirable feelings and much to be encouraged. On the other hand, no one can blame a successful architect, any more than a successful politician, for feeling satisfied with himself and what he has done. And of course it does not matter how it was done if it was done legitimately, and there are various legitimate ways of achieving architectural success. The heiress method has much to commend itself and is extremely popular. For an ambitious, hard-working man there is no surer or more delightful path to success. The self-complacency of the successful architect is delightful to study. Self-complacency is a general characteristic of architects of all classes; even the most

disappointed has an inward conviction (though he may never breathe it to any one) that he is not only the most ill-used man, but an entirely unappreciated one. The successful architect need have none of these feelings. He knows that he is successful and he is justified in knowing it. He will probably tell you so, and point out the strong points in his work. And he is entirely justified in this also; if he does not know where his work is strong it will be essentially weak. If he cannot tell when it is good and why it is good, he certainly will not recognize any deficiencies if other people tell him of them. There can be no harm in knowing all this, and if he were not successful he would not know it. An advantage the successful architect possesses over all other architects is that he can go on his road rejoicing, with numerous clients and fat fees, utterly regardless of the complaints of the critic. If there is one thing other than his bank-account he is to be envied for it is this.

THE sensitive architect is a delicate flower, too fragile for this world, too retiring for the harshness of business, too refined for contact with rough men and women who imagine that they can command his fine artistic gifts for 5 per cent. Of course the sensitive architect always has fine artistic gifts. That is part of his sensitive nature. He cannot bear a hard word, he cannot read an unfriendly remark about his work, he cannot stand being told he ought to do other than he does. He pours out his artistic spirit in abundance upon all the work that passes through his hands. He either is a hard worker or is indifferent to labor, lest he injure his delicate organism by overwork. If he is in earnest he will not spare himself. He is easily upset. Even though he has attained success,—and, delicate as the sensitive architect may be, he may still be able to resist the buffetting of this world long enough to mount to the utmost pinnacle of fame,—he never loses his prevailing characteristic. He is always sensitive; though he be not artistic he will still be sensitive. Properly speaking, his temperament is not suited for business. He has hardly his own proper space in this rough, rude world. But he stays in it, seeking success, striving, working, earnestly, zealously. When the artistic is largely developed in the sensitive architect, he will keep his sensitiveness developed by the ardor with which he works. He will realize that he is an artist, plunge himself into artists' moods, forget that architecture has a business side, and perhaps give more for his pay than he need to. All this is very commendable, though the laborer is worthy of his hire and should exact every cent he can collect. But it is not proper to speak of cents in connection with the sensitive architect. He is above such vile associations. He may live for his art, but above all he seeks to cultivate his sensitiveness. Therein he makes a great mistake. Sensitive men are not for this world. It is the hard-hearted, hard-cheeked who succeed. And we are all in the world for success. When the sensitive architect has obtained it he deserves hearty congratulations, for he has done what many of the rougher of us have not.

THE engineer-architect is a creature of very different caliber. Collectors of architects will find him a difficult species to retain in their collections. As like as not he may have become an architect only because he could not get a job as an engineer. He may thrive, since, as every good building must stand upright, he can usually refer to his preliminary training as a special reason why he can build better than those trained otherwise,—the sensitive architect for instance. But he should not do so. Early training is speedily forgotten, and the engineer can only become an architect after he has carefully forgotten a good deal he first learned. He may not want to do that. He may be filled with a sense of his own importance. He may lay down rules of his own manufacture for guidance in every condition under the sun, and forget that architecture is not like engineering, where everything may be mathematically calculated. It is usually difficult to convince the engineer-architect that he is not always right. He is so ac-

customed to calculating and revising calculations that he does not know a stage in which he may be shown to be utterly wrong. Of late years he has become a well-established personage, and, in the intrusion of architecture upon the field of engineering—has found what he imagines the ultimate form of architecture. Usually he knows more of architecture than the architect; at least he will tell you so. And he may also, in confidential moods, tell you he is the best engineer you happen to know. Probably he is right; at least he is no worse than the architect who will tell you that you know no finer architect than himself. Thus are engineering and architecture united, and thus are the traits of one shown in the other. By himself the engineer can do the very worst things in building. When he calls himself an architect he may be better, but if he does it may again be only because he has done the worst he could before he became an architect. The engineer-architect is the antipode to the sensitive architect. It would be interesting to see the twain in harness together, but it would be very sad for the sensitive man. Sensitiveness cannot fight; it is contrary to its nature. The engineer is usually of a hardier mold and stands not upon ceremony. On the whole, there would appear to be no reason for looking upon him with regard. He may be a good, useful fellow, but he would probably make a better engineer than architect. And is it not written, "Ye cannot have two masters"?

ALL the world does not contain a sadder spectacle than the soured architect. The disappointed man in every walk of life is entitled to the utmost sympathies of his fellow-men. The soured architect is quite likely to have an artistic, sensitive nature. He has started out in life with the utmost hopes of success. Bright dreams of triumphs filled his mind. Fine artistic conceptions floated before his eyes. All the world was bright and gay; life was full within him; success was within his grasp. Then, perhaps, something happens. His first work may not be quite what was hoped for. He may not be satisfied with it himself. He may not have pleased his clients. Even the first work may not have come. This sometimes happens, and the young man eats his life out in bitter disappointment. The world wags round and his practice grows no larger. Hope—blessed though it is—dies hard in some breasts, and hardest of all in the artistic breast, such as the hopeful architect's usually is. Dissatisfaction sets in. The world is no longer as bright as it was. The gaining of a livelihood is too hard a task for a delicate nature. The world is not only not bright; it is positively gloomy. Fewer and fewer become the clients. Men who do no better work, who do not do half so good, are growing rich. There are abundant opportunities for all but him. Can he be blamed for his misanthropy? Can he be censured for thinking ill of a world that has ill-used him, that has, perhaps, sinned against him more than he has sinned against it? Must his work always be condemned, must it always seem bad, even though he has put the best that is in him into it? Only the most heartless nature would hold such a career up to scorn. Only the most thoughtless would find delight in dragging it out into the harsh glare of the sun that has for so long refused to nourish it. There are many such men. Perhaps not more than in other professions, but success in architecture is obtained under such difficult conditions that you are apt to run across them at every street-corner. The successful architect, the sensitive architect, the critic, all men who come in contact with the disappointed architect, should have nothing but a good word for him. He deserves all the kindness in a world that has refused him everything. It is easier to become a disappointed architect than any other. May he find in the next world the comfort, the success, the rewards he has sought in vain in this.

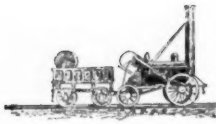
THE bad architect is usually unconscious of his wickedness. Often his practice is entirely disproportionate to his abilities, and it is quite likely to happen that the very worst will have the greatest number

of jobs, and the largest commission list. Fate sometimes ordains that such should be the case, and the man who least deserves success obtains its fullest measure. When the bad architect sins he usually does it in a thoroughly wholesale and barefaced manner. If you ask him for a good piece of work he will produce something appallingly horrible. It is a literal case of asking for bread and getting a stone. And of course as your client is never aware of this, it is possible for a thoroughly bad architect to build up an immense practice out of pure concentrated badness. You doubt it? Then you live in a singularly fortunate city. The bad architect is, in fact, the natural product of a society in which architecture as a fine art is not appreciated. Very few people know what architecture really is; fewer still appreciate it. So it thrives in badness and the bad architect waxes in wealth. He may not mean to be bad; sometimes he can do good work, but evil things seem to come naturally to him; he never seems to realize when he is truly and utterly bad. And so long as architecture is unappreciated by the people who pay for it,—so long as people can be found who will measure art by cost, or by size, or by anything but a genuine artistic standard,—just so long will the bad architect flourish. He teaches some useful lessons. He tells us, first of all, what not to do, but when he has told us that some countless times and never applies the lesson to himself—never seems conscious there was a lesson to learn—it becomes more than sad. For each of these lessons, mind you, is carefully encased in stone or brick or iron, and is intended to last some time. Instances have been known of their surviving the architect himself, and remaining in full flower of horror long after he has been forgotten, save for them. But there are good times coming. The bad architect cannot flourish forever. It may be years before he disappears, but he must go some time. He could readily be dispensed with. His most exaggerated form is when he stops doing good things and takes up with bad ones. There is a consistency in a man who perpetually does what he ought not to do that can sometimes be forgiven; nothing better is expected of him. Like the criminal who has been brought up in a criminal atmosphere from his earliest days, he has some excuse for his crimes. On the other hand, no punishment can be too severe for the cultured, well-meaning, well-trained man who falls deliberately. So the architect who can do good things, yet doth bad ones, deserves a severer punishment than is measured out to the habitual sinner.

THE trumpet-blowing architect speaks with no uncertain voice. Of all sorts he is the most complacent. He not only knows his own worth, but he is determined that every one else shall know of it. He misses no opportunity to hump himself into public notice. He forms connections of every sort. He hobnobs with politicians and—when he can get the chance—with the 400. He joins associations; he makes connections of every sort. Nothing that can proclaim his merits aloud is neglected. All are used, and used for his aggrandizement. And this is not unnatural. If one does not blow his own trumpet no one else will do it for him, save a complacent critic. The faddic critic is the only instance we wot of in which one's own personal, private, peculiar trumpet will be performed on gladly, loudly, and willingly by another person. Whether the blower finds satisfaction and compensation in it is not made public. But the genuine trumpet-blowing architect will scorn such methods as these. Rather than resort to such subterfuges he will stand out before the public,—upon the stoop, if a housetop be not available,—and shout his merits aloud. It is very useful work, albeit somewhat wearing. He is more familiar with the subject than any other living soul, and, as the tendency of modern journalism is towards specialism, it is quite in the usual line that he should speak only of himself. He is usually a strong-minded person, for shrinking souls cannot get up before a scoffing world and tell how great they think they are. And, being strong-minded, he will not hesitate to speak strongly of himself, that being a subject on which he thinks and feels strongly. All of this is very

proper, though it may become utterly wearying at times. There are methods of trumpet-blowing not so offensive as others, but when it is offensive it is usually very much so. The competition for business is now so sharp among architects that the trumpet-blowing species has become a recognized variety. He may not be yet wholly distinct; he may not yet be unpleasantly numerous, but he exists. His rarity, indeed, helps to emphasize his blowing qualities and renders him more conspicuous. At least he has the merit of wishing to be as conspicuous in other people's eyes as in his own. He would not keep his goodness all to himself. That portion of the earth at least he is willing to give away. He is not wholly hoggish. Let us give him credit for what generosity he displays.

AND the Ecole architect. What a fine bird is he! If we have reserved him until the last it is rather with the same sensation that we would put the delicacies of a dinner at the end rather than at the beginning. Besides, shall not the first be last and the last first? The Ecole architect wraps himself in a mantle of Ecolism. He does work, as a rule, exactly as he would do in Paris, and with a fine Parisian touch that is both delightful and inspiring. First and foremost, he puts his beloved Ecole. No alumnus was ever more faithful to his alma mater, though he may have spent but a year or a few months at it. His fidelity is, in fact, only equalled by that seen in certain domestic animals for their masters. He is not content that he himself shall be an Ecole man; every architect who is an architect must do likewise. This is generous, for some men would keep the *creme de la creme* to themselves and not be so harshly judged either. If a young man in search of architectural knowledge presents himself to the Ecole architects, they forthwith begin to shout with one voice "Paris! Paris! Paris!" and they raise so great a tumult, they bring so many arguments to bear, they show how great they expect to be,—they point out the good it has done them, they talk, they argue, they relate incidents, they point lessons,—until the young man has no choice. These are his preceptors, his friends, his guides. He has known them from his youth up. If he would be as great as they hope to be he must follow the same paths. And so he girds up his loins and sails gayly away to the shores of France, where many a bright youth has gone before him, where many happy minds have sought fame and fortune, and.....This is the distinguishing trait of the Ecole architect. He may be successful, he may be sensitive, he may be given to blowing on his own trumpet, he may even be disappointed, but whatever his state, whatever his fortunes may have been, he is first, last, and all the time an Ecole architect. He never realizes that what may be well for one may not be good for another. He may not see that systems of one land may not answer for another. He has tasted of the forbidden fruit. Henceforth he would devote himself to it, and have all do likewise. He knows no higher praise than to be called an Ecole architect. And more, he would rather be an Ecole architect and fail, than succeed without being an Ecole man.



RAILWAYS

Conducted by Thomas L. Greene.

IN a general survey of the railway field perhaps the most important thing to be mentioned is the action of the western railway presidents in forming an association which in effect takes from the traffic officers the power of changing rates, and makes the presidents themselves directly responsible. That the situation called for such an unusual remedy is sufficient evidence of its seriousness. The hard times are felt by the carriers as by other business interests, in the loss of traffic. To add to such losses the cutting-down of the receipts below cost through fierce rivalry is not only unnecessary, but is a positive disadvantage to employés and to all those who are dependent directly or indirectly upon the continued and prosperous operation of the railway system for their trade. The railways form so large a part of the industries of our country that when they are struggling to escape insolvency, every other industry suffers with them.

But it it impossible that there can be such solution of the rate-cutting problem as these presidents propose, without a preliminary understanding as to the conduct of the general business and the share in it which each member is entitled to have. In short, the presidents cannot hope to continue doing the traffic-manager's work in addition to their own unless the way is made clear to them through a modification or repeal of that section of the act to regulate commerce which prohibits pooling. The house committee on commerce at Washington has reported a bill to allow of such pooling under the approval of the interstate commerce commission, accompanying it with a report which certainly sets forth the necessity for such a law very clearly. That the sentiment in favor of pooling is making progress is evidenced by the resolution which was passed at the May convention of state railroad commissioners in Washington. Though opposed by the commissioners of certain southern and western states, the resolution was adopted by a vote of 15 to 8after an excellent paper by Commissioner Dey, of Iowa, and the tacit approval of the interstate commerce commission itself. When fair compensation can be secured to the railways by some such law, we may expect that the companies will again take up the question of improvement to their equipment and road-bed with the purchase of the supplies necessary therefor.

Yet, while we are looking for permissive pooling, we should not forget that the railway associations as they stand are great helps toward the maintenance of rates. The foolishness of the rate war in the south is shown by the statistics of comparison between the southern states and the lines in the so-called "Granger" commonwealths. The number of miles of railway per acre and per inhabitant are twice greater in the northwestern than in the southern states. In spite of this larger proportion of railway mileage, the traffic per mile in Minnesota, Iowa, and Wisconsin is greater than in the states south of the Ohio river, while the average rate per ton-mile is also slightly higher. The sparseness of population in the south and the less number of miles in proportion to territory and population are accounted for largely by the average yield in pounds per acre of the different crops. The census figures for 1889 give this average yield per acre: for cotton, 177 pounds; for corn, 1648 pounds; for wheat, 840 pounds; for tobacco, 702 pounds; for rice, 800 pounds. With such great differences between the traffic to be received from an agricultural acre in the two sections, it is a matter of surprise that the average rates in the south should be lower than in the northwest. If this is true when the regular tariffs are adhered to, how much more true it becomes when the southern lines

are foolish enough to cut their rates heavily. Public opinion ought not to sustain such a rate war, at least until the machinery of the Southern Railway and Steamship Association has been used to bring about a peaceful settlement of the disputed questions by arbitration.

MUCH of the success of modern railroads depends upon the number of tons which the management are able to crowd into a freight train. The average of the southern roads just mentioned is about 160 tons per freight-train-mile while that average in the northwest is about the same. If the average could be made 200 tons, a saving of train expenses would be very great. Companies whose average receipts per ton are small can succeed in holding up against their expenses only by increasing the lading of their trains. The soft-coal roads are conspicuous instances of this necessity. As an instance, the Columbus, Hocking Valley and Toledo Railroad Co. report that over 70 per cent. of their tonnage consists of bituminous coal. As this was all moved in one direction their empty car mileage was 44 per cent. of their total car mileage, while the average receipts for all freight were but six mills per ton per mile. In spite of these great obstacles the company report a fairly prosperous year, success being attributable to the fact that their average train-load was 400 tons. As this average includes the hauling of the empty cars and trains back to the mines it will be seen that the actual lading of a coal-train from the mines must have been very heavy. President Waite is unquestionably correct in ascribing these large figures of train-loads to the increased capacity of cars and engines and the reductions of grades. In like manner the recent history of the Chesapeake and Ohio railroad is one long story of the liberal expenditures of money upon road-bed and equipment in order that long trains of coal may be hauled 400 miles to the seaboard over the Allegheny mountains at the extremely low rate of 3.27 mills per ton-mile; yet the average lading of freight-trains was 283 tons, and the average earnings per freight-train-mile were $1.44, —enough to pay expenses and leave a profit.

While upon this subject it is interesting to note the study of the ratings of engines as told in the St. Paul *Pioneer Press*. It is customary with most roads, we suppose, to estimate the capacity of their freight-engines by the number of cars which they will haul; yet undeniably more tonnage can be handled by an engine where the weight is compact. An engine may haul 750 tons in thirty cars while the same engine may haul 100 tons more if in twenty-five cars. One Minnesota road has carefully mapped out its main line in engine runs, giving the capacity of its locomotives in tons, it being expected that the operating officers will see that each engine is loaded to its capacity in tons rather than in number of cars. The *Pioneer Press* thinks that the system is one which sooner or later must become universal, and indeed it affords a valuable hint to those whose business it is to study transportation economy.

THE proposed reorganization of the New York and New England railroad has had an influence upon railway rehabilitations out of proportion to the importance of the road. The two classes of stock of this company were assessed $20 and $25 per share each, only part of which was represented by new stock in the new company. Such a drastic assessment has had the effect of directing financial opinion to the undeniable fact that the shareholders in a corporation are the ones who must bear the brunt of a failure, since they and they only are to share in a large profit should such be attainable. It is too often forgotten that a mortgage is put on a road for the benefit of shareholders as a cheap and easy way of raising that much capital which is to be paid only a certain rate of interest, leaving all the profits over and above that rate to the stockholders. In short, bondholders are creditors of the company without interest in its success except as that may effect the security of the mortgage; while the stockholders are partners in the enterprise, entitled to the profits and liable for the losses. By a combination of cir-

cumstances certain reorganizations in the near past have been carried through successfully, although they asked sacrifices on the part of the bondholders without proportionate demands upon the shareholders; but it is doubtful whether such procedure is any longer possible. The New York and New England reorganization plan and its success will have a marked influence upon reorganization plans in the future.

THE standard set for public men in England is still high. Mr. Mundella was president of the Board of Trade, a semi-official governmental body somewhat similar to our state railway commissions. It was found that Mr. Mundella was a director in an industrial enterprise whose acts were subject to suspicion, and whose affairs were brought before the court. The judge administered a rebuke to the president of the Board of Trade for allowing his name to be connected with an enterprise which, under suspicious circumstances, inflicted loss upon the investors. The gentleman, in deference to the public opinion expressed by the judge and by the leading journals, resigned his presidency. The doctrine that every public official should be free from even the suspicion of connection with fraudulent concerns is one which should be more carefully lived up to.

LAST month in this Department mention was made of a valuable official report upon the railways of South America, prepared for the Uruguayan government by Don Juan José Castro, an eminent civil engineer of Montevideo. Don Castro has since become minister of the interior with the incoming of a new administration in Uruguay, a fact which promises well for the continuation of the progressive policy pursued in that republic. It is especially fitting that the incumbent of such an office should bring to it such a technical training as to fit him to deal intelligently with projected railway and other engineering enterprises.

In this connection it is pleasant to announce that the Central Railroad of Brazil, through Messrs. Charles R. Flint & Co., of New York, have placed with the Brooks Locomotive Works of Dunkirk, N. Y., an order for sixty locomotives,—thirty passenger and thirty freight. The order represents nearly three-quarters of a million of dollars. Tenders of English engines were made to the railroad, but the government decided to give the order to United States makers. The requirements are for the best and most modern work. Following the statement quoted last month from the report upon the railways of South America by the Uruguayan government, that progress in South America is best attainable through the use of American practice and American methods, this large order is an evidence that the South American field is open to such of our manufacturers as will study its requirements.

THE unprecedented shipments of wheat from the Argentine Republic to Europe which have played such an important part in fixing the present low prices of American wheat, have caused the Argentine railways some embarrassment. To find storage-room they have been obliged to utilize all the buildings they could find, including some of their own station-houses and the like. Mr. F. W. Barrow, general-manager of the Buenos Aires Great Southern railway, has been in the United States for two months studying the American system of operating railways. Mr. Barrow speaks in the highest terms of American methods, as well as the facilities offered him by the railway officials in obtaining information. He believes that the Argentine Republic will become one of the greatest wheat-growing countries of the world, because of the large area of valuable land, the richness of the virgin soil, and the low price of labor, which averages about $10 per month. Mr. Barrow is convinced that American operating principles and methods are better suited to the Argentine railways than the British. All signs point to the growing favor with which American methods in transportation and American machinery are regarded in South America.

THE *Railroad Gazette* prints an interest-

ing statement of what it calls the "consumption" of equipment. By comparing the number of locomotives, passenger-cars, and freight-cars on the books of the Lake Shore and Michigan Southern railway in 1870 and in 1893, after adding the cars and engines meanwhile purchased and built, it is found that on the average 5.4 locomotives, 4 passenger-cars, and 352 freight-cars have disappeared per annum. Meanwhile, the mileage has increased from 1013 miles to 1460; the percentage of equipment destroyed or sold per annum being 1.2 per cent. for locomotives, 1.2 per cent. for passenger-cars, and 2.6 per cent. for freight-cars. This consumption of equipment is much lower than on other roads, for the reason that the management of the Lake Shore has made large outlays for improvements in grades and alignments and has, in consequence, repaired its equipment longer than other roads which have been spending their money for larger cars and engines. What other company in proportion to its business can show as small an annual destruction of equipment as the Lake Shore?

THE convention of state railroad commissioners in Washington in May decided to abandon all attempts in the public accounts to distribute the expenses of operating between passengers and freight. Figures of this sort are of course worthless. Any attempt to divide general expenses must fail, and if any use was to be made of the approximation when arrived at as a basis for fixing rates, it ought to fail. If the sheep-farmer cannot divide his farm expenses between the wool and the pelt, so as to show which of the two yields the most profit, it is useless for the accounting officer to try the same thing in the complicated accounts of our railways.

RECEIVERS' certificates were originally intended to be issued as an extraordinary remedy. The courts looked with suspicion upon every application for such an unusual method of raising money. It was seen that receivers' certificates put another lien ahead of the mortgages which, by their terms, ought to have a first claim upon the property. Hence, it was argued the courts ought not to allow any other debts to come in before them. But gradually a broader view prevailed. It was seen that receivers' certificates represent the commercial conditions; that when the lien of the mortgage has become impaired by losses in operating the road, the issue of certificates to represent those losses does not change the situation. Now it is customary, on the application of those concerned, for the courts to allow the issue of receivers' certificates for any object which is shown to be for the benefit of all concerned. A striking instance of the change in the sentiment regarding receivers' certificates in practice, is that of the issue of $1,000,000 in order that the interest on the first mortgage bonds of the Northern Pacific railroad, due July 1, should be paid. The holders of the bonds of this railroad junior to those of the first mortgage through their committee asked the court to be allowed to lend this amount of money to the receivers for the purpose above stated, and to take therefor receivers' certificates. As these certificates are a lien upon the property after that of the first mortgage, it is seen that the junior bondholders have loaned this money practically on the same security as that covered by their own bonds. This loan was arranged for to prevent a default of the first mortgage which would have still further depreciated these junior bonds. It was conceded that the road had earned the interest on the first-mortgage bonds from its operation, but that the money had been appropriated by order of the court to pay off the claims for wages, supplies, and current expenses incurred previous to the receivership.

MINING AND METALLURGY

Conducted by Albert Williams, Jr.

IT is a matter of common remark, and also a matter that is beyond dispute, that the average character and tone of the precious-metal miners in the far west have been steadily deteriorating for years. Making due allowance for that peculiar human weakness which leads us all to magnify the "good old times" simply because they are old times and are viewed through the illusion of false perspective, there is no denying that the race of miners, taken as a whole, is degenerating. The explanation is simple, though perhaps not what might be anticipated by those who have not been on the spot to observe the change. Civilization and the railroads are to blame. Both are good things. Both have helped mining. Yet in this particular they have done harm. As the railroads advance and transportation becomes easy and cheap, and as the means of subsistence and the comforts of life become more accessible, the hardy pioneers and the enterprising, intelligent miners give place to an inferior set of men, in great part not miners at all either by instinct or by training, who always follow and never lead. Some persons have the mistaken idea that a new mining-camp in an out-of-the-way, unsettled region is always the scene of violence and disorder. This is not borne out by the facts. In such places there are often a few desperadoes and the usual fringe of undesirable parasites, but the general tone of the community is wholesome. The men are there for a purpose, and only enterprise, fortitude under privations and hardships, and thoroughly manly qualities, have brought them there. The farther away from a railroad and a base of supplies, the more rigorous the climate, the greater the natural obstacles, the better the men. The writer has seen many such new districts at a time when the nearest railroad was hundreds of miles away, and when it required some little "initiative" and resource to get there. The first-comers, as a class, were always men of whom the country could well be proud, men capable of doing their own thinking. That they were not chronic strikers, intimidators of workers, dynamiters and destroyers of property, certainly was not for lack of independence. But just as soon as the railroads came they brought an entirely different type of incomers. This has always been so. The California pioneers, usually depicted on the stage and in novels as an uncouth, red-shirted, lawless crew, were in reality an orderly and generally superior set of men. While they sometimes took the law into their own hands, it was from necessity and for the sake of order and the common safety. The early adventurers in Colorado, in Idaho, in Montana, and everywhere that pluck and push were needed, were of the same type. But now the railroads go almost everywhere, living is cheap, there are no hostile Indians to face, and the high qualities once to the fore are no longer demanded. Hence an influx of men not naturally miners but laborers, and a gradual extinction of the old type. Here is another instance of how civilization sometimes advances backward.

WITHOUT power-drills and modern high explosives many of the engineering feats of the day, now becoming so common as to attract little notice, would be, if not impossible, at least economically impracticable. The development of the drills and of the explosives has gone on with equal steps, and in both directions very rapidly, so that the whole system of tunnel-work has been revolutionized in less than twenty-five years. One of the most notable of recent tunnels is that of the Niagara Falls Power Co., which is a tail-race starting just above water-level below the falls, running under the village of Niagara at a depth of 200 feet, and discharging 7250 feet from its

head. Mr. A. C. Rand furnishes the following particulars: The grade of the tunnel is 36 feet to the mile; it is 19 feet wide, and 24 feet high inside the brickwork. The sinking of the shafts was attended with many difficulties on account of the large amount of water entering them, but when they were completed the entire tunnel was excavated in the amazingly short period of six months. The boring was done with power-drills driven by compressed air and was conducted in three benches, the upper one, or heading, being driven first in advance, the middle bench slightly behind, and the lower one last. The excavated rock from the upper benches was withdrawn over platforms, thus permitting simultaneous work on three levels without interference. The cost of the excavation alone was $400,000, and, when walled with arching of brick, $1,000,000. In driving this tunnel, three shafts were sunk in order to expedite the work—one at the portal, 92 feet deep to the tunnel soffit; No. 2, 2650 feet from the portal, 260 feet; No. 3, 5200 feet from the portal, 160 feet deep.

IN the May number of this Magazine (p. 297) Dr. Henry Wurtz offers a suggestion for the preservation of metals subject to corrosion by mine-waters which is worthy of serious consideration by managers who have had trouble on this score. In brief, the plan advocated by Dr. Wurtz is that of electric polarization, it being well understood that the corrosive action is an electro-chemical one rather than a simple solution or oxidation of the metal, and "if a mass of iron is exposed to the corrosion produced by superficial or internal voltaic currents, such metal is to be made, as a mass, the negative terminal of a much stronger current, from a dynamo-electric engine, while the corrosive liquid is made to bathe the positive terminal of such stronger circuit." Dr. Wurtz proposes that a small generator, operated by some small water-power (or perhaps the main pumping-engine), which will work night and day, is to be provided. The positive pole would be carried through an insulated wire down to the lowest sump, terminating in a body of hard-burned coke, while branches of insulated wire would connect, as a negative pole, the pumps, pump-columns, track, iron ladders, and other fixtures, besides which Dr. Wurtz thinks that the movable apparatus (as iron or steel cars, power-drills, etc.) could be temporarily put in circuit. In cases where the trouble is very serious, as is often the case, the inconvenience of the proposed remedy would not be prohibitory. It is of course not the ordinary rusting of iron and steel underground that is here referred to, but the far more destructive action of certain mine-waters, due mainly to the presence of copper and other sulphates derived from the oxidation of pyritous minerals as the mines become open to the air. Several other plans for protection or prevention have already been indicated in these columns, as, for example, the thorough tarring or asphalting of the exposed iron and steel, besides which there are the substitutes of copper, bronze, brass, and one or two special alloys for underground machinery and appliances. In this connection it is worthy of note that the great hydraulic pumping-engines at Clausthal have their cylinders, rods, and pumps all of brass, and makers of underground machinery in this country also use one or another of these substitute metals or alloys for some of the most easily injured working parts. But Dr. Wurtz's proposition is more radical. It does not involve any great expense, and it should certainly be tried when there is little doubt that the plan would work. If applied successfully to the pumps and pump-columns alone, that would be a great achievement.

MONDAY is proved to be the most dangerous day for fire-damp explosions, at least in those collieries which are not operated on Sunday, and this is the prevailing custom all over the world. The explanation is simply that during the suspension of coal-mining the ventilation is likely to become disarranged. Mr. Fairley in his recent work on ventilation * quotes some statistics from the report of the Prussian fire-damp commission, from which it appears that of 1666 explosions recorded,

* *Mine-Ventilation Made Easy.* By William Fairley.

they took place, according to the days of the week, as follows: Sunday, 44; Monday, 327; Tuesday, 271; Wednesday, 240; Thursday, 275; Friday, 259; Saturday, 252—the figures running about evenly for all of the week days except Monday. On the same principle, after holidays or stoppage from any cause more danger of gas explosions is to be expected. The obvious lesson is that, on resuming work after such temporary suspension, especial care should be taken in examining fiery mines for gas before sending down the men.

Of all the states of the Union which have mining-laws—and there are at least seventeen states thus provided—Pennsylvania takes the lead in point of minuteness and completeness of such legislation. As a rule, official intervention in private industries is to be deprecated and shunned, for the intelligent self-interest of individuals and corporations is a more trustworthy safeguard than any official supervision and control. If there is any exception to this axiom it is in the case of laws designed to protect life and property, and this is the object of the mining-laws to which reference is now made, for those laws which apply to the ownership and title of mineral ground are for the most part confusing and a hindrance to mining enterprise. But the Pennsylvania code, which relates to anthracite and bituminous mines separately, and the strict system of inspection under it, have been justified by the result, as has also been the case in Prussia, Great Britain, and France, where much attention has been given to the matter. While the mining accidents in Pennsylvania continue to be deplorably numerous, they have slightly decreased in proportion to the tonnage raised and the number of men at work, notwithstanding the increased difficulties and dangers attendant upon deeper and more extensive workings. The improvement is particularly noticeable in those classes of accidents (such as explosions) where supervision has its best opportunity for good. Minor accidents due to carelessness are almost beyond control. Reading over the reports of the inspectors of the several anthracite and bituminous districts, one cannot fail to be struck by the conscientious, businesslike tone of each and all of them. The Pennsylvania mine-inspectors evidently understand what is demanded of them and are thoroughly in earnest in carrying the law into effect. Sometimes their zeal brings them into conflict with mine-owners and managers, but on the whole they have the hearty support of both employers and employed. All honor to these brave, hard-working men!

In the last complete report of the Pennsylvania mine-inspectors, Hon. T. J. Stewart, secretary of internal affairs, commenting upon the fact that the number of accidents is much larger in proportion to the number of men employed, and also for the quantity of coal mined, in the anthracite than in the bituminous regions, says: "The anthracite mines are much deeper and in many respects are of a far more dangerous character than the bituminous mines. The greater number of accidents therefore is not in consequence of less care and skill in conducting mining operations, but is the consequence of the greater natural dangers. While the mines in some portions of the bituminous-coal regions contain large quantities of gas, other mines are almost or wholly free from it, while no anthracite mine is wholly free from it. Besides, it is far more difficult to ventilate the anthracite mines than the bituminous."

It may be added that the greater amount of gas in anthracite than in bituminous coal-beds, other things (such as depth and the retentive character of covering) being equal, is an argument for, and may be explained by, the accepted theory that gas is not now being produced by chemical changes in the coal, but is merely retained in the pores and seams of the coal and possibly occluded in the more solid portions, ready to be given off when the workings and falls allow. For, if the bituminous coal were still slowly changing to anthracite, the reverse would be the case; while it is easy to understand why the anthracite having parted chemically with most of its volatile matter, should still retain it mechanically.

THE failure of the 18-inch Harveyized nickel-steel armor-plate, at its recent trial at the Indian Head testing-ground, was a complete surprise, former trials of thinner plates having been so very satisfactory. The test-plate represented the side-armor for the battle-ship *Indiana*. It was 16 feet long, 7½ feet high, 18 inches thick from top to middle (corresponding with the water-line), tapering to 8 inches at the bottom. The first projectile, an 850 pound Carpenter shell fired at 100 yards with a muzzle velocity of but 1465 feet per second, badly cracked the plate in two directions; the second shot, a similar shell at 1926 feet velocity, wrecked the plate, breaking it into three pieces. The makers claim that there were evidences of a hidden flaw, and have asked for further trials, which will undoubtedly be made. The matter is a very serious one to the country, involving much more than the mere cost of the armor, for it affects the reliability of the whole system of armor-defense to which our government has committed itself, with the sanction of high ordnance and naval authority.

LIKE all new alloys and processes, nickel-steel and the Harvey method of surface-hardening require long and patient experiment and trial before all the contingencies are fully understood and provided for. In the light of past successful experiment with armor-plates made on the standard American plan, it is too early to lose faith in them because of a single disappointment, though it must be admitted that this failure throws suspicion upon accepted plates. The results of further trials will be awaited with deep interest.

THE "nickel-steel" used for armor is sometimes really a nickel-chromium-steel alloy, the nickel giving toughness, and a small percentage of chromium being added to increase the hardness. It is difficult to secure evenness of distribution of the nickel and the chromium. A correspondent of the *Engineering and Mining Journal*, writing over the initials "F. C.", makes a very important suggestion,—to supersede chromium by tungsten. Speaking of the present alloy, the writer referred to says:

> Theoretically, no objection could be raised, but as chromium is exceedingly brittle, counteracting the effect of the nickel, and at the same time very hard to melt, a lack of uniformity in the plates is almost unavoidable.....If we can add another metal, capable of imparting to steel its hardness without annulling the effect of the nickel the ideal composition for an armor-plate will have been found. Fortunately, there exists such a metal... ...tungsten. With steel, and even wrought iron, any degree of hardness can be obtained..... ...Tungsten is more fusible than chromium, and a more uniform mixture can be obtained; but even if it were not so, slight irregularities would not involve, I believe, such risks as are due to the use of chromium. In this case slight differences in hardness would be the only effect. Tungsten has been used in every kind of steel where at the same time hardness and toughness are called for; from the famous Damascene steel to our best tool and cutlery steel, all contain it in a greater or less amount, and its applicability to armor-plates is obvious. There are strong reasons also, it is said, for attributing the excellence of Krupp's armor-plates, whose composition is kept a secret, to the use of this metal.

EDITORIALLY, the *Engineering and Mining Journal* advances the hypothesis that in the making of these plates—and especially of very thick ones—internal strains are induced, which may have come from the manner of tempering or cooling, or from the temperature at which worked, and suggests that these internal strains may be only temporary, being greatest when the material is first turned out, and gradually diminishing as the molecules of the material rearrange themselves, until they come to an equilibrium, when the internal strain disappears and the piece can then resist to the full limit of which its material is capable. Certain observations seem to indicate that there may be a great deal of truth in this hypothesis, which, if correct, would relieve much anxiety.

SOME interesting information as to mining in China is furnished by correspondents of *Kuhlow's* (Berlin), but it does not offer much encouragement to prospective foreign investors, at least under present

conditions, notwithstanding the known importance of the mineral resources of that country. Mr. John A. Church has already described, in this Magazine,* his experiences in superintending a Chinese mine, and this later correspondence of *Kuhlow's* is fully corroborative. Undoubtedly a great field for profitable mining enterprise remains to be opened there, but at present there are decided drawbacks. China is still nearly undeveloped if we consider it from a modern point of view. On the other hand, the Chinese have obtained ores and coal in the most primitive fashion nearly all over the country. The provinces of Yunnan, Szechnan, and parts of Hunan are rich in good copper-ores. Iron is found in Hunan Kwangtung, first-class ores in Shensi, Shansi, and Honan. Coal is abundant in all the northern provinces. It is sold in nearly all towns and villages for home consumption, near the places where it is found, as the total absence of means of transport does not allow the carrying of it to places more than say ten miles distant from any mine. The working of these mines is simply sinking a shaft in places where coal (and iron and copper just the same) is found near the surface, and abandoning it as soon as water drives the workmen out. Thus the coal gained is mostly soft surface coal, though on the north better coals than anthracite are found. Good coking-coal for use in iron-furnaces has not been found. In Manchuria very good ores of copper, silver, iron, and lead have been found of late. Copper, too, has been discovered in Kansua. There is no doubt a great field for mining enterprises all over the empire if taken in hand properly by strict management, appliances of modern machinery, and the necessary capital. Foreigners are at present not allowed to own any landed property in the interior, nor could such properties be mortgaged to foreign capitalists. This, of course, excludes all chances of foreigners opening and working mines. The only mines worked on modern principles and superintended, though not managed, by foreign salaried engineers, are in Chihli and Hunan. They are semi-official enterprises, and the parties interested are the leading officials and a few wealthy private individuals. Several mines have been started by means of Belgian, English, and German mining engineers, but have not been developed enough yet to enable anybody to judge the probable results obtainable.

* November, 1891, p. 196.

KOREA has shown a more progressive spirit during the last few years, and has encouraged the development of its mineral wealth, welcoming foreign engineers and modern methods. This has been due to the ascendant influence of foreigners, particularly Americans, in state affairs. No very large investments are reported to have come from the outside, but, as in Persia, which also has latterly shown signs of activity in mineral development, what has been done has been mainly on government account.

IN the Witwatersrand (the "Rand") district of the Transvaal—the leading gold-camp of South Africa—the ore, a conglomerate, is crushed in stamp-mills, in which a part of the free gold is obtained by amalgamation and the auriferous pyrites are concentrated, generally by belt vanners, and treated by the chlorination and cyanide processes. The tailings (battery sands and slimes) are worked by the cyanide process. A well-conducted establishment obtains 55 to 60 per cent. of the gold by amalgamation: the rest that is saved is taken from the concentrates and tailings, and it is claimed that only 5 is lost. The average yield per ton in 1893 was 14 pennyweights, crude (worth $17.14 per ounce), and the cost of produced averaged $6.33 per ton, though under unfavorable conditions it was $9.50 and even more. The lowest record was $4.75 per ton. At the average cost of mining and treatment and selling price of the gold, a content of about 7.5 pennyweights is regarded as the usual lowest limit for profitable mining, though a few mines working under specially favorable conditions are said to have earned a slight profit on ore carrying only 5 pennyweights. Herr Schmeisser, the mining expert from whose official report to the German government the foregoing averages are taken,

estimates the probable total output of the Rand deposits at $1,710,506,000 to a depth of 1200 meters (3957 feet), which would take forty years to work out; while Mr. Hamilton Smith, the California expert employed by the Rothschilds, estimated $1,014,000,000 to a depth of 3000 feet.

FROM the report of Mr. Williams, the American consular agent at Johannesberg, the following summary of the Transvaal gold production is obtained: To the end of 1893, the Rand district had produced 4,556,235 ounces (crude), and all the other districts (estimated), 500,000 ounces, or a total of 5,056,235 ounces. At $17 an ounce this would represent nearly $86,000,000. The output of all the Transvaal districts is increasing.

SAMPLING is an art in itself, whether applied to a mine, an ore-pile, a carload, a sackful, or the small samples and specimens to be resampled before assaying. Its importance seems to have been realized in a recent official examination of some iron-ore mines, though the method pursued, as described in the report, is not exactly that which would be adopted in usual practice. In the preface to the report in question, it is said:

> As it is well known, the representation of the quality depends as much on an intelligent sampling as on an accurate analysis of the same. Mr. ——— has endeavored, in collecting samples, to make them as truly representative as possible, by taking a great number of small chips, aggregating *from two to five pounds*, from the full cross-section of the ore-bed; and, where circumstances would not permit of this, he has taken similar samples from old dumps and heaps of ore lying near the openings, or from a great number of points along a general outcrop.

It would hardly seem to be worth while to devote the time, trouble and expense of making 175 (the number actually made) complete analyses of samples taken in this way. A complete iron-ore analysis is quite a tedious and elaborate affair, as any one who may have had to pay a commercial analyst for a set has found out. Samples taken in the manner described give an idea as to the character of the ore, but would not be accepted as a basis on which to sell a large shipment of ore, make a contract or transfer a mine, if the buyer should "want to know."

HERE is another little story about iron-ore: Once upon a time a geologist examined and reported upon an iron ore deposit. The ore appeared above a nearly level surface in the form of a small hill or mound, and that hill was, or was supposed to be, practically all ore. The report went to show how much this amounted to, and so, after stating the specific gravity of the ore (which was a highly scientific plan) it gave the length, breadth, and height of the hill as so many feet each way, hence so many cubic feet of contents, hence so many tons of ore in sight. An inquisitive reader, whose time was not very valuable, went over these figures and found that the extreme dimensions had been multiplied together to make what is called, for short, a right parallelepipedon. That is, the actual shape of the mound was disregarded, and the whole thing squared up, which would give a calculated result about double the reality.

SIMILAR methods have sometimes been adopted in estimating "ore in sight" under ground, and with astonishing results. One distinguished engineer, who ought to have known better, examined and reported upon the great ore body of the Consolidated Virginia and California mines, during the height of the Comstock bonanza excitement in 1874–75. He found $2,000,000,000 worth of ore "in sight." It happened that at the time there were long drifts and cross-cuts, raises and winzes, all in ore and in fact cutting through the heart of the bonanza. Taking extreme dimensions and multiplying them together and the calculated tonnage by the average tenor of the ore, which was there the richest, it was possible to figure out such a product. And many people believed in it. This was only an extreme example of a common fallacy. It has been repeated on a smaller scale in an endless number of reports.

CIVIL ENGINEERING

Conducted by John C. Trautwine, Jr.

THE long spell of exceptionally fine weather, extending over the latter half of April and the first half of May, has been followed, as everybody knows and as might have been expected, by a stormy season scarcely less protracted and of unusual severity. Pennsylvania, east of the Allegheny mountains, seems to have received the lion's share of the damage wrought by this visitation, including the sweeping away of dams, bridges, and other engineering works. At a recent meeting of the Engineers' Club of Philadelphia, Mr. Edwin F. Smith, of the Philadelphia and Reading railroad, in discussing the matter of damage to reservoirs by floods, urged the importance of providing impounding reservoirs with ample spillways, and of seeing that such spillways, after being constructed, are not allowed to become obstructed by the building of footbridges or in other ways.

A striking confirmation of this advice is found in the narrow escape of the Kittanning dam during the floods referred to. The dam, which forms part of the water-supply system of Altoona, lies near the center of the renowned Horseshoe curve of the Pennsylvania railroad west of Altoona, and must have been observed by every passenger rounding that curve and looking down upon the country below. The daily newspapers, indeed, report the destruction of this dam, but fortunately the facts do not bear out this statement. The dam, which drains a steep and wooded area of about nine square miles, has a spillway 34 feet in width and 5½ feet in depth; yet, owing, as it would seem, to a severe wind, occurring at the time of the heavy rains, as much as a foot of water passed over the embankment for thirty minutes, severely scoring the outer slope.

IT is gratifying to learn, from a circular issued by Professor James H. Smart, president of Purdue University, that the damage sustained by that institution from fire in January last is being rapidly repaired, so that, when the fall term opens, the apparatus destroyed will be replaced and ready for use. Advantage has been taken of the calamity to extend some of the existing features and to install new ones which will greatly add to the efficiency of the plant. A new building has been especially designed for the use of the locomotive-testing laboratory, the work of which has already rendered this institution famous, although the investigations thus far carried on have been confined to a single engine. The new installation is so designed that it can receive and test any locomotive whatever, and a new and specially-designed traction dynamometer is being constructed for this work by William Sellers & Co., Incorporated, of Philadelphia, while the Baldwin Locomotive Works, of the same city, are generously providing the two engines of a Vauclain compound locomotive for the steam-engineering department. These will be mounted as a stationary engine, and will be run by steam under the load of a friction-brake. The great Riehlé 300,000-pound testing-machine exhibited at Chicago will be added to the facilities of the testing department.

ALL hydraulic engineers know, and most of them appreciate, the now classic formula which resulted from the combined efforts of the Bernese engineers, E. Ganguillet and W. R. Kutter, and which is commonly known by the name of the latter. Some years ago Mr. Rudolph Hering, the well-known sanitary engineer, suggested to the writer the advisability of preparing a translation of the work * in which these authors describe in detail the development of their

* *Versuch zur Aufstellung einer neuen allgemeinen Formel für die gleichförmige Bewegung des Wassers in Canälen und Flüssen.* Bern: 1877.

formula, and give directions and diagrams for its practical application. We accordingly undertook the work, and when it was well under way the writer visited Europe and made it a point to call upon Mr. Kutter, with whom most of our correspondence had been conducted. He was found occupying modest quarters in "the Pelican," a large but most unpretentious apartment house, most appropriately and picturesquely situated close to the banks of the Aar, and at the base of the cliffs upon which the town of Bern is perched. Upon his next visit, and after the death of Mr. Kutter, the writer called upon Mr. Ganguillet, who then still occupied his position as chief engineer of the canton of Bern, but who now, according to a notice received from his family, has gone over to his co-laborer, Kutter, having died at Bern on May 10, at the age of seventy-six years, and after a long and painful illness.

IN describing, in the Magazine for June, the replacing of the piers of the Iglawa viaduct, it was stated that the cracks found in the cast-iron tubes of the old piers were due to the unequal contraction of the iron and of the concrete with which the tubes were filled. It is claimed by those who are interested in the development of the modern concrete-and-iron form of construction that the two materials expand and contract with practical uniformity under changes of temperature; but, even admitting this, it seems quite possible that under a rapid fall of temperature the cast-iron shells of these pier-legs may have contracted upon their concrete cores and sustained considerable tension, if not actual rupture, before the reduction of temperature began to affect the concrete within.

Our attention has been called to a paper by Mr. Franz Pfeuffer, engineer of the railroad company, in the *Zeitschrift des Oesterreichischen Ingenieur and Architekten Vereines*. Mr. Pfeuffer treats with indignant scorn what he terms the unjustifiable and exaggerated reports respecting the condition of the old piers, and makes light of the report of the super-serviceable gensdarm that it was literally "raining" bolt- and rivet-heads under the bridge. Mr. Pfeuffer attributes the cracks found in the tubes to the rigidity of the roadway, by means of which the shocks of the rolling load were transmitted, without cushioning, to the piers; to the method of attaching the superstructure to the piers, by which free expansion and contraction were hindered; and chiefly to the presence of water which had penetrated between the concrete and the iron shells of the piers and which expanded in freezing. It also transpired that the tubes forming the old pier-legs had been cast horizontally, and that, owing to the tendency of the core to rise through the molten mass, the upper sides of the tubes, as they lay, were in some cases but little more than half as thick as the lower sides, and that these thinner sides contained longitudinal seams filled with slag which naturally rose to the top. In breaking up the piers it was found that besides those seams which had actually opened there were many more which were still closed, but which would undoubtedly have opened sooner or later. Before beginning the erection of the new piers, holes were bored in the old tubes at the ends of the longitudinal cracks, in order to prevent their extension and at the same time to allow any accumulated water to escape. About half of the original iron sleepers of the roadway were replaced with wooden sleepers in order to diminish the shocks upon the construction, and stout wrought-iron rings were bolted around the pier-legs. After this, but few new seams appeared. The authorities ordered the slowing-up of passenger-trains; but, as might have been foreseen, this measure, while it may have tended to the security of the viaduct, did not by any means tend to reassure the traveling public.

Iron tools accidentally dropped into the concrete within the pier-legs during the construction, and imbedded there, were found, upon breaking up the piers, to be entirely free from rust, while one wrench, which was surrounded partly by concrete and partly by cinders, was very badly rusted where it was in contact with the cinders, but preserved its metallic luster where it was in contact with the concrete.

MESSRS THEODORE ALTENEDER & SONS, the Philadelphia manufacturers of drawing-instruments, after a careful investigation of the advantages and disadvantages of aluminum in such instruments, have issued a circular stating that they find it unfit for such use unless so largely alloyed with other metals as to neutralize the advantage of lightness, which they consider a very doubtful one in such tools, however valuable it may be in field instruments. They find aluminum lacking in stiffness and in wearing qualities, easily abraded, so that it soils the hands and the paper, and unpleasant to use on account of a greasy feeling. The addition of a small percentage of aluminum, however, gives a whiteness, and perhaps an additional strength, to the metal which they have been using. They find aluminum for use in the manufacture of drawing-instruments only in cases where it takes the place of wood, as in making triangles and the handles of ruling-pens. The former are made of aluminum, and the latter of an alloy of aluminum and silver. To avoid the soiling of the paper by the aluminum triangles, their surfaces are coated with silver.

THE advancement of the requirements for admission to Cornell University suggests the ever-recurring question as to when we shall reach the limits of the increase of pressure under which we are working and supposed to be living. The struggle for existence is already so keen that those who achieve success are more or less certain, unless gifted with phenomenal constitutions, to become wrecked in the process. If the present rate of increase of the requirements of engineers continues, it will indeed be necessary before long, if it is not always so already, to kill one's self in order to make a living.

It has been suggested that the present tendency to specialization in engineering, as in all other work, tends to alleviate this pressure by reducing the amount of useless material with which the student is at present obliged to charge his mind. It is certainly much to be desired either that some partial relief of this kind may be found, or else that our entire economic strucure may be so remodelled that mankind may be enabled to live under more nearly natural conditions.

MR. GEORGE H. THOMSON, formerly bridge engineer of the New York Central and Hudson River railroad, has issued a set of specifications for structural steel for modern railroad bridges. Not content with waiting for the finished product and subjecting samples of it to tests to ascertain its fitness for bridge purposes, Mr. Thomson begins with the raw material in the ore-pile; and, after insisting that the manufacture, from the raw materials to the finished product, shall be conducted at one establishment, he goes on to provide for the inspection of the manufacture at every stage of its progress. Among the matters specified are that all ingots must be cast from steel melted in acid-lined open-hearth furnaces; that, in order to avoid segregation, no single ingot or casting shall exceed 15,000 pounds in weight; that all ingots shall be bottom-cast; and that no ingot shall be disturbed or removed from the position in which it is cast until it has become sufficiently solidified to obviate "bleeding." Plates and shapes are required to have an ultimate tensile strength not less than 58,000 and not more than 65,000 pounds per square inch, an elastic limit of not less than 38,000 pounds, an elongation in 8 inches of 26 per cent. for plates under 36 inches wide, and of 24 per cent. for wider plates, and a reduction of area of 50 per cent. The instructions to inspectors conclude with the significant words of Herbert Spencer: "Any test is liable to yield untrue results, either from incapacity or carelessness in those who use it"—a quotation which seems hardly up to the standard of rhetoric of that great writer.

IT would appear that the smaller towns, rather than the great cities, are, as a rule, the field for experiments in new departures. In a recent number of the *Journal of the Association of Engineering Societies* Mr. L. E. Chapin describes the sewage-disposal works installed under his

direction at Canton, Ohio; and Mr. J. W. Kittrell now contributes to *Engineering News* an interesting and instructive account of the aëration and filtration plant installed under his direction by the Stanwix Engineering Co., at Ilion, N. Y., a town of only 4000 inhabitants. The water, which is taken from a small stream, is diverted by a low dam into an 8-inch main about 6000 feet long, which conveys it to a storage reservoir placed at a level 190 feet lower. Here the main terminates in a vertical jet, which, in winter, discharges through a plain nozzle, so that the water, falling back in a somewhat compact mass, serves to keep the neighborhood of the nozzle clear of ice. In summer the jet is provided with a fountain consisting of a central vertical half-inch jet, and of smaller jets arranged in circles around the center and inclined at different angles. The computed maximum discharge is nearly 900,000 gallons per twenty-four hours, and the maximum observed height of the center jet is about ninety feet. From the reservoir the water is led to two filter-beds about 300 feet further downstream and 51½ feet below the surface in the reservoir. The floors of the filter-beds are formed of a 6-inch layer of concrete resting upon a 12-inch layer of puddle. Next above the concrete is a series of channels in open brickwork, and upon these are laid, first, a 6-inch layer of fine gravel, and then a 30-inch layer of sand of uniform coarseness. From the filters the clarified water passes to a circular clear-water basin of 500,000 gallons capacity, the flow-line of which is nine feet below that of the filter-beds and 267 feet above the lowest portion of the village. The pipes in the gate-house are so arranged that the village can be fed from the stream or from the reservoir by way of the filter-beds and clear-water basin, or from the reservoir by way of the clear-water basin without filtering, or directly from the reservoir or from one or both filters directly. The total cost of the system, including some sixteen miles of pipe varying from 4 to 16 inches in diameter, 104 hydrants and 180 valves, but exclusive of real estate, right of way, engineering and inspection, legal and incidental expenses, was about $82,000. The cost of cleaning both the filter-beds, without renewing the sand removed, is $8.25. The cost of maintenance is estimated at about 2.7 cents per square foot per annum, or 82 cents per million gallons. The first marked decrease in the capacity of the filter-beds occurs about one month after cleaning, and appears to be due to the presence of a thin membranous film made up of matter held in suspension by the unfiltered water and forming upon the surface of the sand grains. Upon the reversal of the current in the filter-beds, this coat becomes detached and floats on the surface of the water in flakes sometimes as large as one square foot.

At the filter-beds of the Kew Bridge Works in London, the writer noticed, in 1889, that a somewhat similar system of brickwork gathering channels under the filter-bed had been originally used, but that these were afterwards replaced by open-jointed rows of drain-tiles, laid close together side by side over the entire bottom of the filter-bed; while in renewing the bottom of one of the oldest beds, both the brick culverts and the tile drains were dispensed with, and the bottom layer was composed of stones from three to six inches in diameter, the interstices between these being relied upon to carry the water to the central culvert.

IT has always seemed to the writer an absurdity that our communication with the suburbs of towns should be by means of ponderous trains and engines, such as would be used for transportation over long distances, a state of things which he can account for only by that mental inertia which so aptly leads us to follow in the lines laid down for us by our predecessors rather than to map out new ones for ourselves. The first steam-railroad lines were of necessity short ones, and thus the public mind became accustomed to the use of this cumbersome machinery for such light work, but now that the electric railway has evidently come to stay, it can be but a question of a very short time when local and suburban steam lines running heavy and infrequent trains will have been rele-

gated to oblivion. Indeed it seems hardly possible that we should have long to wait for light electric overhead lines, with cars suspended rather than supported, and making very rapid and frequent trips between our great centers of population. The long-talked of St. Louis and Chicago line is a case in point, and something of the same nature, to connect the chain of great cities lying between Boston and Washington, would seem to be in order.

FOR years rumors of a trolley line between New York and Philadelphia have been floating about. At last they seem to be taking definite shape, but the shape is that of a line to be used mainly for local traffic. An elevated road over which light cars would be dispatched at short intervals and at very high speeds would seem to be the desideratum, and, seeing what rapid strides electric science and art have been making of late, we cannot help wondering that something of the sort has not been consummated.

THE development of the trolley system can hardly fall to exert a deterrent effect also upon the construction of elevated steam-railway lines in cities. The plausible argument that the speed of any surface system must, by considerations of safety, be limited practically to that already obtained by horse-cars, is found wanting when weighed in the balance of actual practice; for, even in tolerably frequented streets in our most populous cities, the trolley cars attain between crossings speeds very fairly comparable with those made on the elevated steam roads. Certainly, when we take into account the enormous difference in cost of construction and in damage to surrounding properties, the trolley road must appear as a formidable rival to the elevated road.

MR. WILLIAM A. PRATT, division engineer of the Baltimore and Ohio railroad, located at Philadelphia, has lately shown me a convenient table, which he has prepared and distributed among his trackmen, and by which they are enabled very readily to determine the radius of any existing circular curve. The table is based upon that arc of the gage side of the outer rail which is cut off by a chord forming a tangent to the gage side of the inner rail. The middle ordinate of this arc is therefore the gage of the track, 4′ 8½″. The table gives the length of the arc referred to, both in feet and in rail-lengths, and gives also the length of the chord in feet. In flat curves, where the arc contains a considerable number of rail-lengths, the counting of these lengths in the arc enables one to take the radius of curvature immediately from the table. In sharper curves, where the rail-lengths in the arc are comparatively few, it may become necessary to measure the chord, which may, of course, conveniently be done by a transit with stadia.

A PROJECT for the construction of a canal in western Tennessee, to connect the waters of the Mississippi and Tennessee rivers and thus to shorten by some two hundred miles the passage of boats from the Tennessee to the lower Mississippi, has been discussed at intervals for half a century, and it has been given some prominence recently by the daily papers of that section. Trustworthy accounts from the same region, however, indicate that the project is not likely soon to progress beyond the paper stage.

SOME years ago, as described in papers read by the engineer, Mr. L. L. Buck, before the American Society of Civil Engineers in 1881 and 1886, the old Niagara suspension bridge built by Roebling in 1852 underwent important modifications, iron replacing stone in the piers and timber in the trusses. More lately there has been some talk of replacing the entire structure. Mr. Hobson, engineer for the Grand Trunk railway and Mr. Buck have devoted some study to the matter, but a recent letter from Mr. Buck reports that nothing has been definitely determined upon.

MECHANICAL ENGINEERING

Conducted by Henry Harrison Suplee.

THE desirability of having some yielding point in a mechanical structure, so that if slippage or breakage occur it shall be in a known and unimportant place, is now an accepted feature in machine-design. There are, however, instances in which this point has been met in a manner the success of which is only really appreciated when its absence reveals how well it has done its work in directions not previously known. That belts will slip is well known, and that such slippage often materially acts to mitigate the violence of the shock which would otherwise occur in starting heavy machinery is also highly appreciated. The extent to which this action has reduced the injurious action of sudden stresses on line shafting has been more fully revealed, however, by the frequent breakages which have taken place in shafting when rope-transmission has been substituted for belting, all other conditions having remained unchanged. In an instance which recently came under the writer's observation this point was clearly brought out. The rope-transmission was one in which the driving-rope made several coils about the grooved pulleys, these latter being of wood; and the power being delivered from the shaft in the same manner, there was no opportunity for slippage, as there would have been had belts been employed. Such an arrangement is really as rigid as is the hawser by which a boat is made fast to the post at its dock, and when any sudden shock comes upon a shaft under these conditions the only possible yielding is that permitted by the torsion of the shaft. The result was an abnormal series of shaft-breakages, these not being traceable to any especial shock, but evidently due to the repeated stresses producing torsional strains which became cumulative in their action, until the long-suffering shaft, like a piece of wire bent back and forth, broke under some load which would scarcely have affected it at all, had it not been the "last straw" following many others, each having contributed its share toward the final result.

IT is the importance of having some positive, yet gradual method of imparting motion in power-transmission which has led to the designing of the numerous forms of friction-clutches which are so widely known, and, with all due respect to those already in use, it may be hinted that the perfect clutch is yet to be made. For situations in which it is required that there should be either positive engagement or complete release, numerous forms have been made which are entirely successful, but when a heavy power may suddenly be thrown against a great resistance, and that too without the operator being able to exercise any proportional degree of judgment as to the graduation of the engagement, it must be admitted that there is room for the exercise of much inventive ability. Probably the shifting belt, with its fast and loose pulleys, is yet one of the best devices we have for this work, but every one knows how imperfect and unsatisfactory it is. In many of the western sawmills a slack belt, gradually tautened up to its work by a tightening pulley, has been found the most practicable method for use with the wide, short belts so often necessary in that class of machinery. Another, and better-known, instance is the slippage so often observed in the driving-wheels of a locomotive-engine when the train is heavy and the track wet.

The difficulty with all such actions lies in the fact that, in the engagement of the driving parts, the control of the gradual increase of motion, upon which the smoothness of action depends, has not that degree of certainty which enables the element of human judgment to be entirely omitted. The perfect clutch should, so to

speak, "weigh its load," and so give automatically just such proportion of time to the engagement that the shock upon all parts of the transmission to which it belongs may be that which has been predetermined by its designer, regardless of the variations in its load, or of the suddenness with which it is thrown into gear.

THE increasing use of photography in all branches of engineering is well-enough known to need but little comment, but it is worthy of remark that it has not been given the same opportunity in mechanical engineering as it has in some other branches of the art of directing the forces of nature for the use and convenience of man. In civil engineering, in architecture, and indeed in all the outdoor branches of work, photography has been freely used, while in mechanical engineering it has been mainly used to make pictures of machines for the subsequent "promotion and publicity" of the business interests of the manufacturers. This latter branch of work is indeed most laudable and necessary, but it is not of this department of "engineering" that we desire now to speak. In nearly every large machine-shop, and indeed in most small ones, the blue-print process is now used for reproducing drawings, and hence the originals are in the form of tracings. Such tracings, being made quite clear and black, may be readily copied in the camera, and it is surprising to see how much reduction they will stand while yet retaining their full clearness and legibility. Drawings made upon "Double Elephant" size sheets, if made so as to give good blue-prints, can readily be reduced on a $6\frac{1}{2}'' \times 8\frac{1}{2}''$ negative, the tracing being placed in the printing-frame with a sheet of white paper behind it, care only being taken to avoid reflections of light in the glass which covers it. Blue-prints from such negatives are, for many purposes, as good as the original drawings, and have many uses for which the originals would be ill adapted. A set of such prints enables the engineer to carry important data with him away from the shop, and a full set stored away in a small safe-deposit box in a bank-vault is a provision against loss of important designs by fire, only attainable otherwise at much greater cost.

Another most important use of photography is in procuring accurate and hasty records of work in various stages of completion, temporary devices, experimental combinations, etc., and a home-made photograph of some early form is sometimes most welcome evidence in many an important patent suit. Such photographs may be made when time or ability to produce a sketch is not possibly available, besides which the photograph leaves nothing out; nor, unless tampered with, does it put anything in. Sometimes, indeed, it produces quite different evidence than was intended or desired by those using it. In one instance which has come to the writer's knowledge, a photograph was put in evidence as fixing positively the date of a certain construction as far back as the Centennial Exhibition. The point in question was the presence or absence of a certain set-screw, and the photograph, which was one of an exhibit at the Centennial, was produced to prove the absence of the set-screw. Apparently there was none visible, but an expert photographer thought he saw something in an otherwise black shadow, and the original negative was hunted up and an enlarged transparency of the portion in question made, when the set-screw, the absence of which had been positively asserted on the witness stand, was most plainly visible in the very photograph which had been introduced to prove its absence.

Photographs of test-pieces may be made useful to show details which would be most difficult to describe by words only, but here the greatest care must be used to avoid introducing errors of distortion. It has been truly said that photography cannot lie, but it is no less true that it can be "persuaded" to an extent which to the uninitiated seems hardly credible. Those who have seen at photographic exhibitions prints representing the same individual seated at a table playing chess with himself and with himself also looking on, or a headless individual calmly carrying his own head in a tray, can readily understand

how methods similar to those employed in the production of such work might also be used in many far more deceptive ways upon mechanical subjects. Such work, however, is quite capable of being detected by those who are expert in photographic tricks, and need deter no one from making this most valuable art as serviceable in the details of mechanical engineering as it has already been made, in architecture for instance, and the above hints, which may be old to some, may yet suggest other applications not yet in use.

THE question of the value of labor-saving machinery depends somewhat upon the point of view of the individual, but if that individual be assumed to be the manufacturer, and not the laborer whose work is "saved," the value is often capable of being most positively demonstrated. Probably a traveling crane is more properly termed a "labor-saving" machine than almost any other, as it replaces the service mainly of what is termed the "laboring" gang. The introduction of electric power for operating such cranes has extended their use so as to include much yard work where it would formerly have been at least inconvenient to transmit power by other methods, and such cranes have proved themselves to be labor-saving machines indeed. In one instance it has been practically demonstrated that the entire cost of a most extensive system of electric traveling cranes for yard use was more than entirely met by the economy in labor attained in the first year of their use. It is not often that such data can be accurately obtained, as new devices are generally intended to perform work which previously had not been performed at all; no basis for comparison being available, but when, as in the above instance, human labor is replaced by mechanical devices for performing practically the same work, it is possible to obtain reliable data free from disturbing conditions. This example clearly proves what has already been asserted without such conclusive proof, *i. e.*, that in America at least human muscle is too expensive to compete with mechanical power.

This is hardly the place to discuss the subject from the standpoint of the laborer, but it may not be amiss to remark that the employment given to the workmen engaged in building the cranes is a new field of labor which would otherwise not have existed, and also that any devices which tend to abolish the use of men for purely animal work while also creating employment in a much higher grade of service, must ultimately tend to the advantage of the workman, whatever may be the immediate hardship wrought to those who are displaced at the time when the machines are introduced.

THE commercial value of London fog has been brought to notice in a rather curious manner by a remark made at a recent meeting of the Institution of Mechanical Engineers, by Sir Frederick Bramwell, to the effect that the unusual amount of sunshine during the past year had had a most depressing effect upon the dividends of the electric-lighting companies. While this has doubtless been the case, nothing was said about the increase in the dividends of the concerns which had been relieved from the expense of electric-lighting in the day-time, and surely the loss of the lighting companies must have been the gain of the users, whose point of view should hardly be ignored.

THE death of the late Reinhard Mannesmann, Sr., of Remschied, Germany, removes a man at once notable for his own work and also as the representative of one of the oldest and most important industrial establishments of Germany. In the United States the name of Mannesmann is perhaps best known in connection with the seamless rolled tubing, the machines for producing which were invented by Mr. Mannesmann and his sons; and the writer well remembers the interest with which the members of the American Society of Mechanical Engineers listened to the first description, by the late George H. Babcock, of this beautiful and valuable process. As Mr. Babcock neatly expressed it, in closing his remarks, "they take a hole, and roll a tube around it." But this process was but one, and indeed one of the

more recent of Mr. Mannesmann's achievements, his most important work being in connection with the development of the steel industry in Germany.

Born in 1814, and naturally destined to enter the works established and conducted by his grandfather and father at Remschied since 1797, Reinhard Mannesmann did much more than merely conduct the industry on in the course of its natural growth. In many ways he showed himself in advance of the times, rapidly as the times themselves advanced; and in some instances he was so far in advance as to be obliged to wait awhile until the times had in some measure caught up with him. This was notably the case with the Chenot "direct process," which he undertook to establish in 1855, and in connection with which he was probably one of the first to suggest the electromagnetic separation of ores, a method which is now, forty years later, being pushed in more than one direction, in connection with the present state of the science of electromagnetism. Following this advanced attempt to develop the direct process, Mr. Mannesmann and his eldest son proceeded to make an exhaustive study of the molecular action which occurs in the production of crucible steel, with the result of developing the crucible-steel plant which became the successful rival of Sheffield, and carried away laurels at Munich, Paris, and, last year, at Chicago.

With all this industrial and scientific work came also opportunities, which were not lost, to take active part in the furtherance of the solution of social and economical problems. His relations with his men, his town, his country, and his sovereign were such as to make him noted had he accomplished nothing more; while among scientific men of every nation he held those close and cordial relations which more and more seem to indicate that it is through just such men as Reinhard Mannesmann that we may yet hopefully look forward to the realization of "the parliament of man, the federation of the world."

THE intimate relations which exist between the work of the electrical engineer and the mechanical engineer have been well brought out in the discussion which recently occurred upon a paper on the cost of electric energy, before the British Institution of Electrical Engineers. The questions of cost naturally involved the problem of the generation and utilization of steam and the subject drew forth the usual contentions about shell boilers against tubulous boilers; short-stroke high-speed engines against longer strokes and slower rotative speeds; jacketing and superheating, etc. Professor Unwin spoke most wisely when he said that "it was a matter for consideration in each particular case which method should be adopted," although he himself appeared to think that the best results were to be obtained by the use of long-stroke high-speed engines, with superheated steam to meet the question of cylinder condensation. Professor Unwin spoke in superlative terms of the practice of steam-engineering in Alsace, and called it the "best school of steam-engineering in the world," and the experience of forty years in the use of superheating under the conditions there common showed an economy from that source of at least 20 per cent., without any of the supposed ill effects upon the cylinders or valves. Another point in the same discussion, which bore also upon the domain of the mechanical engineer, was the question of the relative efficiencies of various methods of power-transmission, and Professor Kennedy said he looked forward with much interest to the tests of rope- and belt-driving about to be made in Belgium. These tests, to which reference has already been made in this Department, should certainly add much to our working knowledge of subjects which are at present almost entirely treated by empirical methods, and as Professor Kennedy truly remarked "there is very little exact knowledge available as to the power wasted by different means of transmission." In the present state of the development of electrical energy, it is to the skillful installation of the mechanical portions of the plant that commercial economies are mainly to be attained, and these relate almost entirely

to the problems involved in the generation and transmission of the motive power.

THE ingenious idea of obtaining an unlimited supply of heat for the generation of power by boring a deep hole and so tapping the central heat of the earth, assuming the correctness of the theory of the existence of a central heat, has recently had some additional data furnished upon which to base further calculations. The deep-bore hole at Wheeling, W. Va., shows a temperature of 135° F. at a depth of 5000 feet, the increase in temperature during the lower part of the bore being about one degree for every 75 feet of depth. This was a more rapid increase than appeared at less depths, but assuming this rate to be uniformly continued it would require a depth of about three-and-a-half miles to obtain a temperature equal to that of steam at 100 pounds pressure. Just what results might be obtained in volcanic countries does not appear, but surely in such regions steam ought to be produceable by natural sources of heat much nearer the surface. After setting Niagara at work it may be next in order to impress into service either the geysers of the Yellowstone or even Vesuvius himself, and long before the available coal-supply is exhausted we may be drawing from natural sources of energy beside which the already paling brilliancy of natural gas shall be as the flickering tallow candle of past days.

IT is not always easy to estimate the value or extent of the influence of tradition in matters of mechanical research. Many things appear to be so because we have become so accustomed to taking them for granted that we do not consider them necessary subjects for investigation, and in further researches we are very often apt to extend matters which are true within certain limits to points far beyond those to which they are useful or even correct. This influence of tradition is far more powerful in connection with work along already-existing lines of thought, as is well shown by the reluctance of older engineers to take up the practical study, for instance, of electricity, or of any similar subject in which they feel the uncertainty of their established notions of the relations of cause and effects. For example, the manner in which the action of gravity might be influenced by local magnetic attraction might lead an otherwise well-trained mind, ignorant of the action of magnetism, to reject observations and deductions which failed to accord with earlier traditional ideas. A mind untrammeled by such tradition might seek for phenomena which would explain the otherwise mysterious action and so be led on to discoveries only awaiting such an investigator, and it is to just such minds that the solutions of the present mechanical problems will reveal themselves. The light of past experience is our most valuable guide in all things, but it must be directed forward, not backward, showing us "what to do, and how to do it, rather than what has been done and who did it."

COMMENT & CRITICISM

Air-Ships and the Motion of Birds.

SOME remarks on aërial navigation in the Mechanical Engineering department of the Magazine for May suggest some thoughts which I should like to see in print. It seems to me that most of our experimenters on air-ships and methods of supporting loads in the air are too close imitators of nature; that is, they strive to get their mechanical motions to act too nearly in the manner that a bird's wings seem to them to act, losing sight of the fact that a bird's pinions are capable of being distorted, and are distorted, during flight.

Our regulation animal painter has always produced pictures of horses running, showing beautifully-curved limbs, and we would not accept anything else. It was left to our friends, the Japanese, to picture the running horse with perfectly straight limbs, such as we would find under a sawbuck, were we so unfortunate as to be familiar with the latter domestic animal.

It has been left for the camera to show that the straight limbs were the correct delineation, some recent photographs of a race showing some famous horses running with legs perfectly straight, and the whole animal appearing to be balanced on the two fore-legs. The camera has indeed done much to dispel our false notions regarding the grace of moving animals, where the motion is too great for individual periods to be appreciated by the eye, for it shows that a bird in flying keeps its head constantly in motion, extending and contracting the neck, maneuvering the tail, and almost producing a rotary motion of the wings in order to change its course, the latter being as near a rotary motion as can be attained by bone and sinew.

If the bird could get a rotary motion with its wing, we should find what would approach as near to the propeller as feathers would admit of.

We might continue our argument with reference to the race-horse. Its speed limit probably will be reached ere long, when he who would produce a swifter one must breed a horse whose legs do not have a reciprocating motion but a rotary one; in short, bring the joints of the legs to a common center and revolve them, when they would become the spokes of a wheel and the appearance would be that of a locomotive with a single pair of drivers, about midway the animal.

My similes of course take much of the poetry and grace from the movements of our beautiful animals, but show, to my way of thinking, that in order to attain high rates of speed one must give up the reciprocating and adopt the rotary motion, and if ever aërial navigation becomes a success, as it must be at a high rate of speed, it leaves but the propeller to work with, which must leave very many of the workers in this line on the wrong track entirely.

But flying is not as much of a necessity as it was before the telephone came into use, and it will be still less a necessity when the telautograph comes into general use, for when we can communicate with and make a sketch for a man in a few minutes, or even seconds, with the width of the country between us, what need have we to fly to him? As to the success of air-ships, we must resort to that well-worn expression, "It is possible but not probable."

SAM. H. LIBBY.

Schenectady, N. Y., May 15, 1894.

Western Sympathy for Coxey.

IT is hardly possible for any one living in the east, who has not lately traveled westward or who does not read certain western newspapers, to appreciate the feeling about political and economic matters that prevails widely in the west. By this term is not meant the west of a few years

ago, but what was then "the far west" and is now the newer west, to which Chicago seems to be an eastern city. I refer especially to the states of Iowa, Kansas, Nebraska, Colorado (and all the other silver-mining states), and in less degree to the Pacific-coast states.

Perhaps it will not be credited by eastern and foreign readers of THE ENGINEERING MAGAZINE that here the Coxey idea is regarded in quite a serious light by very many. If I say that it is looked upon as "a protest" against an intangible but sincerely believed-in wrong which can be righted by legislation, possibly my meaning will be understood. Hard times always have the effect of making some people believe that government should and could do something. Each always has some political panacea for commercial and industrial ills; though, taken in mass, the ideas are rather mixed. Hence the "greenback," the "granger," the "populist," the "fiat-money," and the whole host of visionary ideas, mostly of the paternalistic order. Here we are repeating the experience of the two or three years following the panic of 1873. In the west, as elsewhere, people feel the stagnation in business, the scarcity of work, and low prices for their products, and seek for a cause and a remedy. Many of them think they find the one in the oppression of employers, of corporations, of capital (which is always spoken of as "the money power"); the other, in an act of congress. They forget that if anybody has suffered in the general depression it is those who have most at stake, and they become bitter. The Coxey crusade, however absurd, is only one mode of expressing this feeling; but lately it happens to have been the most prominent. Why, you ask, should it be especially favored in the west?

It must not be supposed that the class referred to is made up altogether or mostly of very ignorant persons. On the contrary, the school facilities and the general grade of intelligence are as high in the west as elsewhere, and there is less of the ultra-ignorant foreign element that is found in the large eastern cities. But the education is that of the common schools and of the multitude of so-called "universities." It is that which leads people to think, and often to think very crudely. I do not in the least uphold the saying that "a little knowledge is a dangerous thing"; but it sometimes tends to create a misplaced reliance on judgment concerning matters that require a special study. The strength and safety of the country are in the average intelligence and education of its voters, and their common-sense brings them out all right in the end. One after another these queer crazes have their day, then die out. But meanwhile the habit of talking politics and economics—a good thing in itself—leads temporarily to some erratic results, which in time cure themselves.

Very many people, who admit that the Coxey army is head crank and tail tramp, encouraged it because of a vague notion that it might lead to something, somehow, though it cannot be said that they have any faith in Coxey's two cure-all bills. Their feeling is not merely the natural human sympathy with those in distress, of whom there are unquestionably large numbers, not counting cranks and tramps. It goes very much farther, but in no very definite direction.

The causes for this sentiment are various. In the western agricultural states the farmers have mortgaged themselves up to their eyes, and want Uncle Sam to pull them out. In the silver-mining states the decadence and in part extinction of a great industry has worked hardship, and those who suffer think that the monetary legislation of last year and the whole national financial policy are unjust and oppressive. The ordinary man of sense and education has his own point of view; only the philosopher can look at things from various sides. But how many philosophers are there? F. C. CHASE.

In the Far West, June, 1894.

The Mining District of Ecuador.

IN the Magazine for May Mr. Arthur L. Pearse, in an article on gold-mining in South America, has this to say regarding Ecuador;

There is a great field for prospectors here,

and doubtless a great deal of mineral wealth, but the difficulty of coping with the tropical vegetation and with the Indians, one of the tribes, the Yibarra, being cannibals, renders the development very slow.

I have recently returned to the United States from Ecuador, where I was engaged in the preliminary survey and examination necessary to start the plant for placer gold-mining on the property of the Cachari Company. This property is located on the Cachari river, a tributary to the magnificient Rio Santiago, about thirty to thirty-five miles from the Pacific coast, and about eleven miles on a straight line north of the Playa d'Oro Mining Co.'s property, near the frontier of Colombia, and right in the gold-mining part of Ecuador.*

I was in Ecuador about four months, surveying and exploring every day. Now as to the vegetation, it is tropical and of course rather heavy in places, but not so bad but that my party, with from four to six axemen, could run from 3000 to 4000 feet transit and level line every day, cutting a path through the forest ten to twelve feet wide, large enough for ditches and pipe-lines, and that in spite of several hours' heavy rain daily. The old Spanish planters have—in a primitive way—mined gold there for at least 150 years back, the proof of which was found in the many ditches and several reservoirs I ran across in my survey. These ditches, 8 to 10 feet deep and 2 to 5 feet wide, and some with almost vertical slopes, were even now free of vegetable obstructions, and in such a state of preservation, that the Cachari Co. intend to utilize several of them in the construction of their mining plant, which is now going on. The Playa d'Oro Co. are also constructing miles of ditches and pipe-lines without encountering any difficulties from vegetation. The chief obstacle to placer mining in Ecuador, at least where I was, is found rather in the formation of the country, which consists of numerous very irregular valleys, ridges, and "lomas," running in all directions, caused by the equally numerous creeks and rivers, which of course in places again necessitate longer and more expensive ditches and pipe-lines.

As to the "cannibalistic Indians," every one who went to Ecuador with me, as well as I myself, returned "all whole." In the part where I was, which at present is the real mining district of Ecuador, I "heard stories" about tribes of wild Indians still existing in the far interior, east of the Cordilleras or Andes mountains. This vast territory is very wild, entirely uncultivated or explored, and supposed to be inhabited only by these Indians, who may even now, during "hard times" roast a fellow-being for "a square meal." If there is any mining to be done there, it is at present an impossibility simply for lack of means of communication.

One of "the stories" I heard told how these Indians, in the beginning of the century, raided a prosperous city of 20,000 inhabitants on the eastern slope of the Andes, killed all the males and children, and carried off the women as their unwilling "better halves." It is supposed now that the influence of this "white blood" has since made their descendants more gentle and tame. The fact is, that the Indians I saw,—and I had several of them from the interior in my party,—were "rather tame," living mostly on rice, beans, and plantains. They were very ugly and decidedly dirty and primitive in their manners and dress, but they gave us no fear on account of cannibalism.

OSCAR A. F. SAABYE, C. E.

New York, June 4, 1894.

* See article by Russell F. Lord, C. E., in THE ENGINEERING MAGAZINE for May, 1892.

The Obstacle in Peru.

IN several articles—first and last—about Peru, I notice that contributors to the Magazine wonder why that country is not entered by Americans and "developed;" in fact, why nobody seems to take any interest in it, although it is in many parts an Eden and contains mineral wealth enough to satisfy the world. There is no mystery about it whatever. If you were plumped down in Lima by a balloon you would find out from your own observation in less than an hour what the reason is. Catholicism is the answer to the riddle. "Religion" is the supreme concern, and all business

affairs are mere side-shows that may get along the best way they can, only they must keep out of the way of "religion." Of course the "religion" is not such as the people of the United States have been accustomed to call by that name. It is not Christianity any more than Buddhism is. It is the Power of the Church, but they call it "religion" to make it more endurable. Americans and Englishmen are called "protestants," and are at heart considered as dirt. Not to be a Catholic is to be on a par with the most degraded riff-raff of the world; and a non-Catholic is fair game for anybody who may care to dirty their fingers with him. A *protestante* is ostracized. Some cultivated and foreign-educated people may treat him decently and civilly, but they will not like him. The teachings of the *padres* that have been ground in the inmost fibers of the Peruvian's nature will assert themselves more or less as long as life lasts. So you see that a foreigner is surrounded by enemies, as it were, and he can never count on the pretended friendship of his acquaintances. All the clap-trap of spectacular religion is forever going on, and the weekly occurrence of "feast-day" prevents one from carrying on a regular business like manufacturing. The workmen *dare* not work on "feast-days," and what with the interference of masses and vespers, and angelus, and matins, and what-not, a foreigner gives up the game disgusted and quits. Only natives can stand the racket. This ostracism on account of religious belief—aside from the intolerable bother the church requirements produce—is the big factor. It never lets up. You are never allowed to forget it, and it works against you all day, and even when you are asleep at night. So long as Peru is without the blessing of religious freedom all the talk about gold and india-rubber and other products down there will come to naught, as sure as the sun shines. N. J. S.

Frankfort, Ky., June 4, 1894.

The History of Portland Cement.

IN Professor Newberry's article on cement, in the June issue of the Magazine, we notice that he says that the manufacture of Portland cement was begun in the United States at Coplay, Pa., in the year 1878. This is an error, as the Coplay Cement Co., at Coplay, Pa., started the manufacture of "Saylor's Portland cement" in 1872, but were not entirely successful until the beginning of 1875. From this time on, they have made an excellent Portland cement. General Gilmore, on December 19, 1876, writes as follows: "I found 'Saylor's Portland cement' on exhibition in the International Exhibition at Philadelphia. There were fourteen Portland cements exhibited, all of which were tested under my direction. 'Saylor's' cement stood among the five best specimens." WILLIAM G. HARTRANFT.

Vice-president Commercial Wood and Cement Co.

Philadelphia, June 9, 1894.

Captions That Went Astray.

IN printing the June Magazine, there was an unfortunate transposition of the captions of two pictures accompanying Mr. David L. Barnes's carefully-prepared paper on "The Future and Present Locomotive." As printed they read—

Fig. 9—Mountain climber, dacapod type;

Fig. 12.—High-speed passenger locomotive "Flying Dutchman" type—

but in each case the cut which appeared should have been used over the other caption. The engraving which appeared on page 404 as "Figure 10" was one not intended to be used in the Magazine, while the proper cut did not appear at all.

CURRENT TECHNICAL LITERATURE

PROGRESS IN FLYING-MACHINES. By OCTAVE CHANUTE, C. E. New York: *American Engineer and Railroad Journal.* [Cloth 8vo. vi-308 p. $2.50.]

AERIAL NAVIGATION. By J. G. W. FIJNJE VAN SALVERDA, late Administrator of Public Works of the Netherlands, and Advisory Councillor for Hydrotechnic and Railway Affairs. Translated from the Dutch by George E. Waring, Jr., with notes concerning some recent development in the art. New York: D. Appleton & Co. [Cloth. 12mo. vi-209 p. $1.25.]

THE change which has come over methods of invention and which has almost relegated to the past the visionary inventor is nowhere so distinctly indicated as in the modern treatment of the subject of flying-machines. Not so very many years ago any man who allowed it to be known that he was devoting any of his time to the invention of a flying-machine ran great risk of finding himself considered a candidate for an insane hospital, but here we have a well-known and highly-esteemed past-president of the American Society of Civil Engineers venturing to appear as the author of a treatise upon this subject; while at the same time another well-known American engineer gives to the public a translation of the work of one of the most distinguished engineers of Holland upon the same branch of mechanical science.

Mr. Chanute's book is largely historical in character, and as such is most interesting. He dismisses at the outset the subject of balloons as having been treated already in his previous work on aërial navigation, and proceeds to discuss, practically in chronological order, the various plans which have been suggested for attaining success in aërial flight by strictly mechanical means. These he classifies into three main divisions: wings and parachutes, screws to lift and propel, and aëroplanes. The first group is the natural result of a number of more or less imperfect observations of the flight of birds. It is not surprising that the imperfect nature of these observations should have led to many blunders. Nearly all the early experimenters assumed that the flight of birds was accomplished by the flapping action of their wings alone, and from the time of Leonardo da Vinci down to the present day a long series of wing devices, intended to enable man to imitate this supposed action of the bird, shows the persistence with which a mistaken idea will cling to the mind of man.

Rebelling against this succession of failures, and doubtless influenced also by the action of windmills, spiral toys, and similar devices, the mechanics of more recent days have expended much thought upon the construction of machines the action of which was based upon the principle of the screw propeller, and these form the subject of Mr. Chanute's second division. The twirling propeller toy is doubtless known to almost every one, but it carries no part of the weight of the motor to which it owes its action, and, even when actuated by twisted rubber springs or other simple form of power storage, it has yet to be shown that this system carries within it the promise of success. When it is considered that Giffard's experiments showed that the direct-lifting action of screws, unaided by any combination with aëroplanes, was only about 27 pounds per horse-power, it will be seen that a motor of 27 pounds weight per horse-power would just be able to lift itself; hence, until much lighter motors than are at present known are introduced, there is little to be expected in this direction.

By far the most interesting branch of the subject is that which includes the so-called "aëroplanes," and the greater portion of the works of both Mr. Chanute and M. van Salverda is given to this, the most promising field of recent investigation and experiment. The aëroplane is really the direct outcome of more accurate and intelligent observations of the flight of birds, and especially of the difference between

"soaring" and "flapping" flight; and the differences which appear in the action of various kinds of birds when studied in the light of modern methods of investigation and with the aid of instantaneous photography have led to most valuable results. The difference between this form and that just referred to, is shown by the fact that Professor S. P. Langley's experiments have demonstrated that a screw which could scarcely lift 30 pounds by its direct action can, in combination with an aëroplane, lift as much as 200 pounds. Mr. Maxim's experiments, conducted with all the care due to the ability of such a practical investigator, have practically demonstrated that a lifting capacity of at least 133 pounds per horse-power can be obtained, and it is well known that several modern torpedo-boats are equipped with motors weighing not more than 60 pounds per horse-power.

An aëroplane is really little more than a kite in which the string, the pull upon which holds it to its correct angle to the wind, is replaced by the motor. When, as in the case of Herr Lilienthal's machine, there is no motor, the horizontal component of the weight of the aëronaut is so directed as to keep the angle of the aëroplane at the desired pitch, and the really remarkable results which the latter gentleman has obtained bid fair to develop into most definite form. These cannot be more than hinted at in these pages, and we must refer those who are interested to the volumes themselves, and indeed both books should be in the library of every one who is at all interested in this subject.

To all who desire to study the present status of the problem in the light of what has been done in the past, Mr. Chanute's work is especially valuable, containing, as it does, historical data of wide extent, gathered from sources which in many instances are not readily accessible, and its thorough perusal may enable many an investigator to avoid errors into which he would have fallen but for the record of these experiences and failures of the past.

The book of M. van Salverda is in some respects more popular in its character, but none the less scientific in its treatment of the subject on that account. Besides the original work of the author, as written in 1892, it contains copious extracts from a later pamphlet, written by him in the light of the experiments of Langley, Maxim, and Holland, and the translator has added a most valuable appendix giving in abstract the substance of Langley's "Experiments in Aërodynamics," Holland's essay on "Mechanical Flight," and Langley's later and very important paper on "The Internal Work of the Wind," thus placing the very latest information upon the subject in a shape for intelligent and comparative study. HENRY HARRISON SUPLEE.

HYDRAULIC POWER AND HYDRAULIC MACHINERY. By Henry Robinson, M. Inst. C. E., Professor of Civil Engineering, Kings College, London. Second Edition. With numerous Woodcuts and Plates. London: Charles Griffin & Co., Limited. Philadelphia: J. B. Lippincott Co. [Cloth. 8vo. xvi–226 p.]

FROM the title of this book and that of its author one would be led to suppose that it was intended either as a text-book or as a work of reference on hydraulics, including hydraulic machinery. One is still further led to believe this from the opening chapters. The first chapter, occupying nine pages, is devoted to the discussion by means of simple mathematics of the discharge through orifices. This discussion, while extremely elementary, is exceedingly good as far as it goes, but falls far short of the requirements of even an elementary text-book. The second head —gaging water by weirs—is still less comprehensive, occupying but three pages. It is so short, however, that it scarcely deserves the title of chapter, nor does the author give it this name. This is followed by a chapter on flow of water through pipes. Although twelve pages are devoted to this subject its treatment is very superficial and incomplete. The most valuable portion of this chapter is the discussion of the "critical velocity" of flow as investigated by Professor Osborne Reynolds, which is defined as that velocity at which, in a given pipe, the water, instead of following parallel lines, suddenly bursts into eddies. In the equation for velocity $v = \frac{R^{\frac{1}{2}}}{C^n \sqrt{S}} \times (1 + \frac{T-50}{K})$ and that for discharge in cubic feet per second—

$Q = \frac{D^{\frac{5}{2}} + ^{\frac{1}{2}}}{P^n \sqrt{S}} \times (1 + \frac{T-50}{600})$ it is stated that

below the critical velocity n may usually be taken as 1 while at the critical velocity it suddenly jumps to about 4. Several diagrams are given to show how this great change may be explained, and other results of Professor Reynolds' experiments are given without such qualifications as would be necessary in a book such as we are supposing this to be thus far. Three large plates intending to show by reference (1) the flow of water in smooth pipes (lead, tin, copper, etc.), (2) the flow of water in iron pipes, and (3) the flow of water in brick culverts, accompany this chapter. The curves in these plates are plotted from equations given on each and are intended as labor-saving devices for the determination of results under similar conditions without resort to calculation. Every one appreciates the value of diagrams of this kind when they are reliable, but these particular diagrams are rendered almost entirely useless by the meagerness of the instructions as to how to interpret them. These three introductory chapters are by far the most meritorious in the book and yet there is scarcely a manufacturer of turbine- or other water-wheels in this country who does not include in his catalogue fuller information on all of these subjects, arranged in better shape for use by the practical man than is contained in these pages.

The remainder of the book is taken up by descriptions of individual hydraulic machines or installations—the characters of which will be sufficiently indicated by the following titles, "cyclone hydraulic baling press," "anderton hydraulic lift," "the Otis elevator," "North Hudson County railway elevator," "Pearsall's hydraulic engine," "hydraulic ram," "Tweddell's hydraulic rivetter," etc. Many of these are well illustrated with copper-plate engravings, but in most cases the descriptive matter is so inadequate and trivial as to be valueless to the student and to the engineer alike. An illustration of this is the treatment of the Greathead shield and method of operation. This subject might well take up a volume by itself, but is here dismissed in two pages, which include a woodcut, and a large copper-plate in addition. The result is that no one who did not before know something about the Greathead system could gain from this chapter any clear idea of what it is, and to him who did know something about it the chapter would be utterly useless.

In conclusion, it is difficult to classify this book. It is a curious medley or potpourri of odds and ends thrown together apparently without judgment or purpose. It is *not* a trade catalogue, though it partakes somewhat of the nature of one without having the value to the engineer that many American trade catalogues have. It is in no sense a text-book, nor could it by any stretch of the imagination be thought of as a work of reference. It is a fairly good specimen of the bookmaker's art, but reflects no credit either upon the author or upon the judgment of the publishers, and we can scarcely conceive how it could have come into a second edition.

NELSON W. PERRY.

A MANUAL OF PRACTICAL ASSAYING. By H. V. F. Furman, E. M. First edition (second edition in press). Illustrated. New York: Wiley & Sons. [Cloth. 8vo. vi-390 p. $3.]

IT is not often that current practice in assaying,—that is, the practice of the great metallurgical works and the commercial laboratories, not that of the schools,—is described so that students and assayers who have not had this experience may profit by it. A busy assayer may occasionally find or make time to bring before the profession some new wrinkle that he has hit upon, but information of this kind is scattered and incomplete, and of only partial value to one who needs a general exposition in available form. Mr. Furman has done a most valuable service in preparing the present volume, which is (within its scope) the best work on practical assaying yet issued. It is not merely a book for students, but one which would be of assistance to almost any working assayer. There is a great deal of matter in most chemical text-books about which the student is left in some uncertainty,—for instance, where a choice of methods is presented and no guidance given. Mr. Furman is always very decided in stating the reasons for his

preference for one method or style of apparatus rather than another, and is very clear in describing manipulations. The rapid methods in vogue in the technical laboratories of this country are given especial prominence, while some of the longer and more exact ones (such as are usually taught in the schools and then discarded when the assayer gets into practice) are also given in detail. There is a great deal that is generally taught—and that ought to be taught, in order to inculcate precision and present a wide range of methods—that has to be supplanted by more direct methods. At a mill or smelter, where the samples come in upon the assayer by the dozen and the reports are expected at a certain hour, it is necessary to adopt new systems and half learn the business over again. The trick of handling large numbers of assays quickly, quietly, and systematically, without becoming rattled, is the essential point. Rapid work does not mean slovenly work, but a judicious economizing of time and effort. It is in this direction that this "Manual of Practical Assaying" constantly points.

A. W., JR.

MINE VENTILATION MADE EASY, WITH AN APPENDIX. Containing Answers to 155 Questions Selected from Various American Examinations for Mine-Inspectors and Mine-Foremen. By William Fairley, Ph. D., F. G. S., M. E. Scranton, Pa.: The Colliery Engineer Co. [Cloth. 12mo. 110 p.]

THIS is a carefully-prepared, concise work for the use of mine-officials and mining students. It is written in simple language and clears away many of the seeming difficulties attending this rather complicated branch of colliery engineering, often regarded as the great stumbling-block in the way of the student, and the mathematical side of which is often approached with diffidence. Mr. Fairley has made a very thorough treatise on the subject, which will be appreciated by those who have occasion to study or consult it. The work has already appeared as a serial in *The Colliery Engineer*. Students and miners who are preparing themselves for examination as mine-inspectors or foremen will find the selected questions and answers given in the appendix valuable as a "coach," as they indicate the points to which most prominence is given in such examinations.

A. W., JR.

THE INDUSTRIES OF RUSSIA. BY THE IMPERIAL MINISTRY. Editor of the English Translation, John Martin Crawford, United States Consul-General to Russia. Five Volumes. St. Petersburg: Published by the Government. New York: G. P. Putnam's Sons. [Paper. 8vo. liv-280 p.; ii-296 p.; xxxii-488 p.; x-98 p.; xii-265 p. $6.]

THE literature of the World's Columbian Exposition was richly enhanced by this series of volumes, due in its inception to the czar's idea that, however successful the choice of exhibits for the Fair might be, they could not alone convey an adequate idea of the productive forces of the empire and its industrial development. Hence the various branches of the imperial ministry undertook, with the aid of specialists, the preparation of a work which should be an authentic résumé of Russian technical progress up to date. The first two volumes review manufactures and trade; the third is devoted to agriculture and forestry; the fourth, to mining and metallurgy; and the fifth, to Siberia and the great Siberian railway. These reports are treatises or monographs, and not catalogues of exhibits. The editor of the English translation, Consul-General Crawford is thoroughly familiar, not only with the Russian language, but with many of the principal branches of industry.

DIRECTORY TO THE IRON AND STEEL WORKS OF THE United States, Canada, and Mexico. Twelfth Edition. Corrected to March 1, 1894. Philadelphia: American Iron and Steel Association (James M. Swank, General Manager, No. 261 South Fourth street). [Cloth. 8vo. xii-292 p. $5, or 20s.]

THIS very admirable and comprehensive work, covering the changes made in the development of the industries represented since the appearance of the preceding edition (February, 1892), leaves nothing to be desired by those for whose use it is intended. It is concisely gotten up, every page being devoted to the legitimate purposes of a directory, without any advertising features whatever. The book serves also as a convenient statistical summary, and its indexes guide one at once to any feature sought for. Altogether the work may be commended as an excellent model for the compilers of industrial directories generally. Orders may be sent to Mr. Swank, at the address given above.

NEW BOOKS OF THE MONTH.

American Institute of American Architects.=Proceedings of the Twenty-seventh Annual Convention, Chicago. August, 1893. (Including Proceedings of the World's Congress of Architects.) Alfred Stone, Editor. Chicago: *Inland Architect* Press. [Paper. 4to. 399 p.]

Burke, M. D.=Brick for Street Pavements. An Account of Tests Made of Bricks and Paving-Blocks. Second edition, with a paper on Country Roads. Cincinnati, Ohio: Robert Clarke & Co. [Paper. 8vo. 108 p. 50 cents.]

Luber, Oscar M.=The Assayer's Guide; Or practical directions to assayers, miners, and smelters, for the tests and assays, by heat and by wet processes of the ores of all the principal metals. New and enlarged edition. Illustrated. Philadelphia: H. Carey Baird & Co. [Cloth. 12mo. 283 p. $1.50.]

Means, James.=The Problem of Manflight. Showing what has been done in aërial machines and the probability of what may be done in the future. Illustrated. Boston: W. B Clark & Co. [Paper. 8vo. 20 p. 10 cents.]

Paterson, Howard.=The Navigator's Pocket-book, Arranged for Immediate Reference to any Navigation Subject. New York: Scribner. [Leather. 24mo. 6-177 p. $2, net.]

Patton, W. M.=Practical Treatise on Foundations. New York: Wiley & Sons. [Cloth. 8vo. $5.]

Rothwell, Richard P., *editor.*=The Mineral Industry, its Statistics, Technology, and Trade, in the United States and Other Countries, From the Earliest Times to the End of 1893. [Second annual Statistical Supplement to the *Engineering and Mining Journal.*] New York: Scientific Publishing Co. [Cloth. 8vo. xl-864 p. $5.]

Smithmeyer, John L.=The Competitive System in Government Architecture. A plea for better buildings and better laws, together with a history of the movement to secure them. 1873-94. Washington, D. C.: Gibson Brothers. [Paper. 8vo. 23 p.]

Smithsonian Institution.=Annual Report of the Board of Regents, Showing the Operations, Expenditures, and Condition to July, 1892. Washington: Government Printing Office. [Cloth. 8vo. 811 p. $1.]

Stokes, Anson Phelps.=Joint-Metallism: A Plan by which Gold and Silver Together, at Ratios Based on their Market Values, may be made the Basis of a Sound Currency. (Questions of the Day Series.) New York: Putnam. [Cloth. 12mo. 8-124 p. 75 cents.]

Traill, H. Duff=Social England. A record of the progress of the people in religion, laws, learning, arts, industry, commerce, science, literature and manners, from the earliest time to the present day, by various writers. Vol. I. New York: Putnam. [Cloth. 12mo. $3.50.]

Trevert, E.=Electrical Measurements for Amateurs. Illustrated. Lynn, Mass.: Bubier Publishing Co. [Cloth. 3-117 p. $1.]

United States=Twelfth Annual Report of the Geological Survey, 1890-91. By J. W. Powell, Director. Vol. I—Geology. Vol. II—Irrigation (including report by H. M. Wilson on Irrigation in India.) Washington: Government Printing Office. [Cloth. 8vo. xiii-675 p., 53 plates; xviii-576 p., 146 plates.]

Walker, Francis A.=Bimetallism. A tract for the times. Boston: Damrell & Upham. [Paper. 8vo. 24 p. 10 cents.]

Watson, E. P.=How to Run Engines and Boilers. Second edition Illustrated. New York: Spon & Chamberlain. [Cloth. 12mo. 115 p. $1.]

Williamson, Benjamin.=Introduction to the Mathematical Theory of the Stress and Strain of Elastic Solids. New York: Longmans, Green & Co. [Cloth. 12mo. 7-135 p. $1.50.]

Williams, G. H., *and* Clark, W. B.=Outline of the geology and physical features of Maryland, with a geological map of the State. Baltimore: Johns Hopkins Press. [Paper. 8vo 8-67 p, maps. $1.]

Worthington, T. Locke.=The Dwellings of the Poor and Weekly Wage-earners in and Around Town. With an Introduction by G. V. Poore, M. D. New York: Scribner's. [Cloth. 12mo. $1.]

Wyatt, Francis.=The Phosphates of America. How they occur, how they are mined, and what they cost. With practical treatise on the manufacture of sulphuric acid, acid phosphate, phosphonic acid and concentrated superphosphates. Fifth Edition. Illustrated. New York: Scientific Publishing Co. [Cloth. 12-mo. $4.]

NEW TRADE CATALOGUES.

Any of these catalogues free on application to the manufacturers.

McGrath & Collins, Cohoes, N. Y.=Emery Grinders, Polishing and Buffing Machinery for all Metals. 24 p.

The Perfection Sash Balance Company, Rochester, N. Y.=Illustrated Price List. 32 p. [Spring sash-balances, elevator-gates and doors, show cases, etc.]

The Sebastian-May Company, Sidney, Ohio.=Foot Lathes and Engine Lathes. Emery Grinders, Planers, Shapers, Chucks, etc. 16 p.

American Railway Maintenance Syndicate, Philadelphia.=The Columbian Metallic Railway Ties. 16 p.

The St. Louis Well Machine and Tool Company, St. Louis.=Well Machinery, Tools, and Supplies for Sinking Wells of All Kinds. 48 p.

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The H. A. Williams Manufacturing Company, Boston.=Oilers, Lamps, and Brass Specialties. 28 p.

The Hart & Hegeman Manufacturing Company, Hartford, Conn.=Hart Switches and Flush Plates. 20 p.